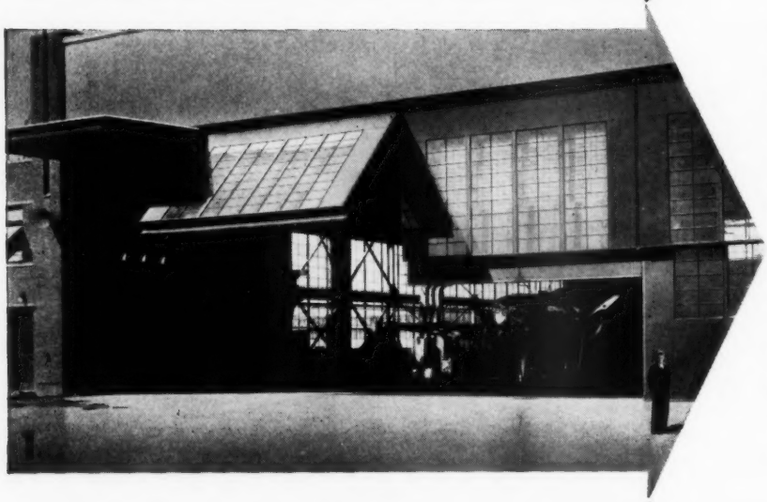
PRODUCT ENGINEERING

OCTOBER, 1939

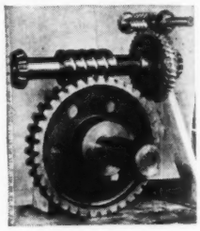
1. DEPENDABLE
2. EFFICIENT
3. ECONOMICAL

. . . these alloys of NICKEL



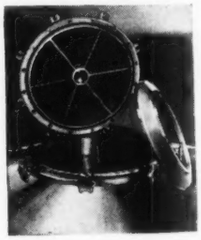
1. HANGAR MAINTENANCE:

The Dominion's largest doors, on Trans-Canada Airway's new hangars, are opened and closed by Nickel steel worms and chill-cast Nickel bronze gears. To obtain tensile strength of 51,000 p.s.i. the Richards-Wilcox Canadian Co., Ltd., London, Ontario, Canada, specified these gears cast with this composition: copper, 87.50%; tin, 11.00%; Nickel, 1.50%. The addition of Nickel to bronze improves density and strength without impairing anti-frictional qualities of gear surfaces — assures long trouble-free service life.



2. BOTTLING OPERATIONS:

Metals used in bottling equipment must be corrosion resistant, strong, bright and attractive and be able to withstand repeated cleaning operations. Above all they must be non-contaminating to safeguard the beverages with which they come in contact. Solid Nickel Silver possesses these improved properties. Combining good structural qualities with resistance to corrosives, and eye appeal, it can be readily and repeatedly cleaned because there are no platings or coatings to wear away or flake off. Therefore, the Crown Cork and Seal Co., Baltimore, uses Solid Nickel Silvers for many parts of their high speed bottling and capping machines which come in contact with the beverages.



3. FOUNDRY PRACTICE:

Shrinks and cracks forced remelting of one of every four swing spout fixtures! That was the unprofitable record of the Universal Brass Manufacturing Co., Los Angeles. Rejects ate the heart out of profits. By adding 1% Nickel grain structures were refined making castings so pressure-tight and sound, that 90% of rejects were avoided. The uniformity of Nickel-bronzes cuts machining costs, too. Consultation is invited on money-saving applications of Nickel alloyed materials.

THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL ST., NEW YORK, N. Y.

PRODUCT ENGINEERING

What's Coming—Design details of new features in the 1940 automobile models that are of interest to engineers will be presented in November *P.E.* A section will be devoted to illustrations and text covering improved styling, mechanical improvements and the uses made of new materials by the automotive engineers.

Of paramount interest and value to all machinery designers will be a comprehensive article by R. R. Moore of the United States Bureau of Standards, presenting the results of exhaustive researches on the strength of screws subjected to vibratory stresses, with special reference to aeronautical applications.

Of equal importance will be an article by T. C. Lloyd on the characteristics of condenser-type motors, and an article by J. Earl Simonds, consulting designer on plastics, showing the latest methods for joining plastics and metal. Also, additional feature articles and the regular departments.

Cover Picture—The bill of material for modern machine tools includes almost everything that modern industry is prepared to furnish.

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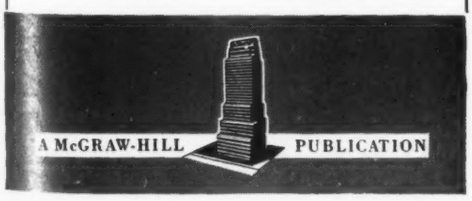

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During the past several years engineering executives in these companies have written PRODUCT ENGINEERING telling how and why they read each issue, cover to cover.

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- Baker Perkins Co.
- Bendix Products Div. Bendix Aviation Corp.
- Bucyrus-Erie Co.
- Clearing Machine Corp.
- Federal Machine & Welder Co.
- Fidelity Electric Co.
- Foster Machine Co.
- Frick Co.
- Giddings & Lewis Machine Tool Co.
- R. Hoe & Co.
- Reece Button Hole Machine Co.
- Ingersoll Milling Machine Co.
- Kearney & Trecker, Inc.
- Landis Tool Co.
- Master Electric Co.
- Niagara Machine & Tool Wks.
- Noblitt-Sparks Industries
- Oliver Farm Equipment Co.
- Piper Aircraft Corp.
- Porter-Cable Machine Co.
- Proctor & Schwartz
- Rayon Machinery Corp.
- Stromberg-Carlson Telephone Mfg. Co.
- Timken Silent Automatic Div.
- Walker-Turner Co.
- Wayne Pump Co.

the Value of Reading the Advertising!

Letters from men prominent in design-engineering work repeatedly point out how the advertisements in PRODUCT ENGINEERING help them develop their companies' products. Here is what they say . . .

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FOSTER MACHINE COMPANY

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"We notice that very frequently our designers are asking for detailed information covering the different advertised subjects and often this is the only medium by which they are called to their attention."

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"We of the aircraft industry are constantly scanning the field for new ideas in connection with the design and construction of airplanes, and we find that the advertising section of magazines, such as Product Engineering, is a very fertile field for ideas and suggestions, which will improve and simplify our product."

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Victor L. Darnell, Chief Mechanical Engineer
THE MASTER ELECTRIC COMPANY

PROMINENT PRODUCT ENGINEERS HAVE FOUND IT PAYS

PRODUCT ENGINEERING

GEORGE F. NORDENHOLT, *Editor*

BIG JOBS TO BE DONE

PRICES OF LABOR and materials are bound to increase. That has always been one of the effects of war, and regardless of any legislative attempts at price regulation, we will experience during this war an upward trend in costs. To be sure, no one can foretell how much any given material will go up in price, nor how much wage rates will increase. But prices will go up, of that we can be certain.

Admittedly, some materials will increase in cost far more than others. For this reason it will often be considered more economical to change from the material that has become extremely high priced to one that has not experienced a comparable rise in price. But, as designers know only too well, changing the material specified is not something that can be done in an offhand manner. Often the cost of a finished part made of a cheaper material will be greater because of a greater amount of labor required. And in the problems that soon will be faced, this factor will be emphasized.

Depending on the shape, size, dimensional accuracy, amount of finished surface, and number of pieces required, plastics at fifty cents a pound might be cheaper than aluminum at thirty cents a pound or zinc at ten cents a pound. The figures quoted are solely arbitrary. Similarly, for certain parts a plastic molded piece might be cheaper than a stamping, but if resistance and fusion welding were to be used in the stamped assembly the reverse might be the situation.

The whole picture is further complicated by the many highly improved new production machines that will be developed. Conditions created by the war will demand the maximum efficiency in the use of man power. It is a safe guess that the next year will see the further development of amazingly efficient automatic plastic molding presses, and resistance and fusion welding equipment even more efficient than that now available. Production methods that are now still in their infancy in so far as extent of commercial use is concerned will be developed to a much higher degree and will find greatly extended use. Regardless of the tremendous progress in the design of machine tools, forthcoming further improvements will in many instances change entirely the picture of machining costs versus stamping, die casting or molding costs.

No one can foretell the future, but this we do know. Engineering designers are facing big jobs to be done. The general problem is always three-fold: (1) The relative merits of the different materials to perform the service required; (2) The respective production methods that can be used for the different materials, for example, casting, molding, stamping and welding; and (3) The total cost to produce the finished piece. Continuously changing prices in labor and materials, plus continuous improvements in production machinery will demand repeated changes in product design. They always do but the urgencies of war will accelerate the rate of change.

Product Engineering will keep its readers continuously informed about new developments that might suggest or demand changes in design. In our pages we will report experiences of engineers in all fields in the redesign of their products and in their adoption of new methods and materials to fit the ever-changing conditions. New or improved production processes will be described and analyzed with reference to their possible effects on design. To this end, the editors of *Product Engineering* will have the cooperation of the staffs of the twenty other McGraw-Hill publications and the assistance of the McGraw-Hill Washington Bureau.

MACHINE TOOL DESIGN TRENDS

Culmination of a ten-year period of intensive research and engineering studies make available to American industries methods of cost reduction and increased productivity with machine tools that incorporate and make use of new materials and parts in new designs

IN THE DEPTH of the 1929–1933 depression, machine tool research departments and engineers took advantage of slack time to search for new methods and new improvements which they knew would be required to meet the increasingly exacting demands of America's manufacturing enterprises when recovery arrived.

"At the 1935 Show, some of the fruits of this research had taken form—but a large share of the new concepts and ideas originated during depression days still required further testing and development before they could be placed on the market. During the last four years this testing and development has taken place. Machines which will be shown at this year's Show represent, in fact, the culmination of a ten-year period of intensive research and engineering studies, designed to make available to American industries methods of cost reduction and increased productivity which, I am convinced, substantially surpass in performance machine tool equipment which has thus far been available."

Thus stated Wendell E. Whipp, president of the National Machine Tool Builders Association in his announcement of the plans for the 1939 Machine Tool Show. The fact that, unfortunately, the advent of the World War of 1939 impelled the cancellation of the 1939 Machine Tool Show does not in any manner detract from the amazing developments that have been taking place in the design of machine tools over the past few years. In the following pages some of these developments are shown and explained by pictures, drawings and text. Admittedly the brief presentations shown here cannot do full justice to the innumerable new developments that have taken place. Nor should it be assumed that all of the most outstanding developments have been covered in this presentation. Numerous new designs fully as striking and amazing as any of those included in this number of *Product Engineering* have been omitted because of space restrictions, but will be shown in forthcoming numbers.

Hydraulic Drives and Units

Undoubtedly the most widespread trend in the design of machine tools has been the increasing use of hydraulic operating units. Since the Machine Tool Show of 1935, not only have many more machines adopted hydraulic drive and control, but the hydraulic system has been greatly refined and further developed. One of the principal factors entering into this has been the more extensive use of solenoid operated valves by means of which the electrical drive and control system has been interlocked with the hydraulic system in order to attain "fool-proof" operation and a maximum of automatic control. Properly placed limit switches, opened or closed by moving elements of the machine, control the solenoid operated hydraulic valves, thus achieving not only automatic operation, but also preventing any of the hydraulically operated elements from being actuated at the wrong period of the cycle.

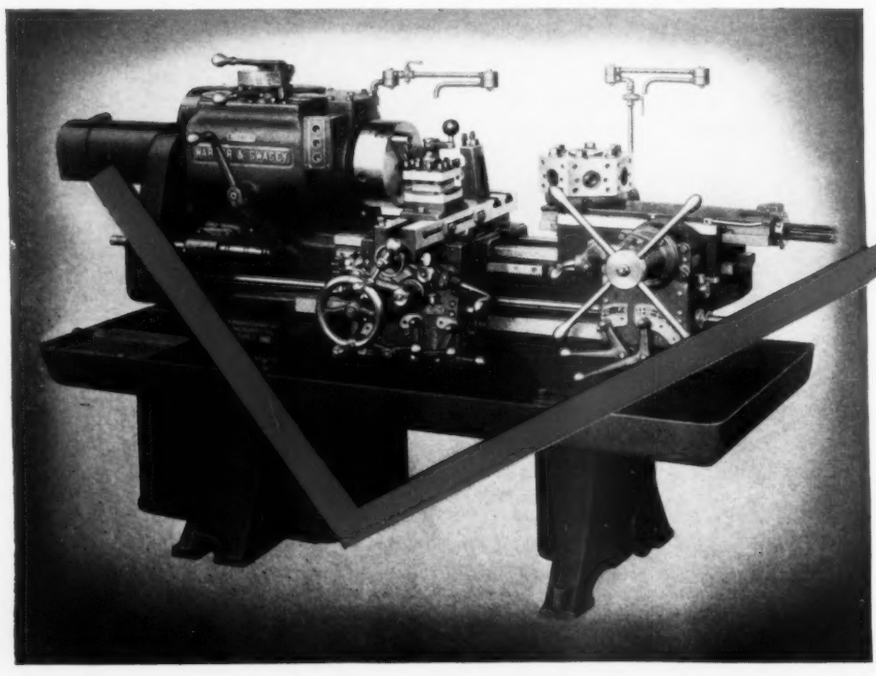
In addition to the automatic control valves and special valves developed by the manufacturers of hydraulic units, a number of machine tool engineers have developed their own special automatic valves. Such valves are manually operated, mechanically operated, or actuated by pressure differences in the hydraulic system.

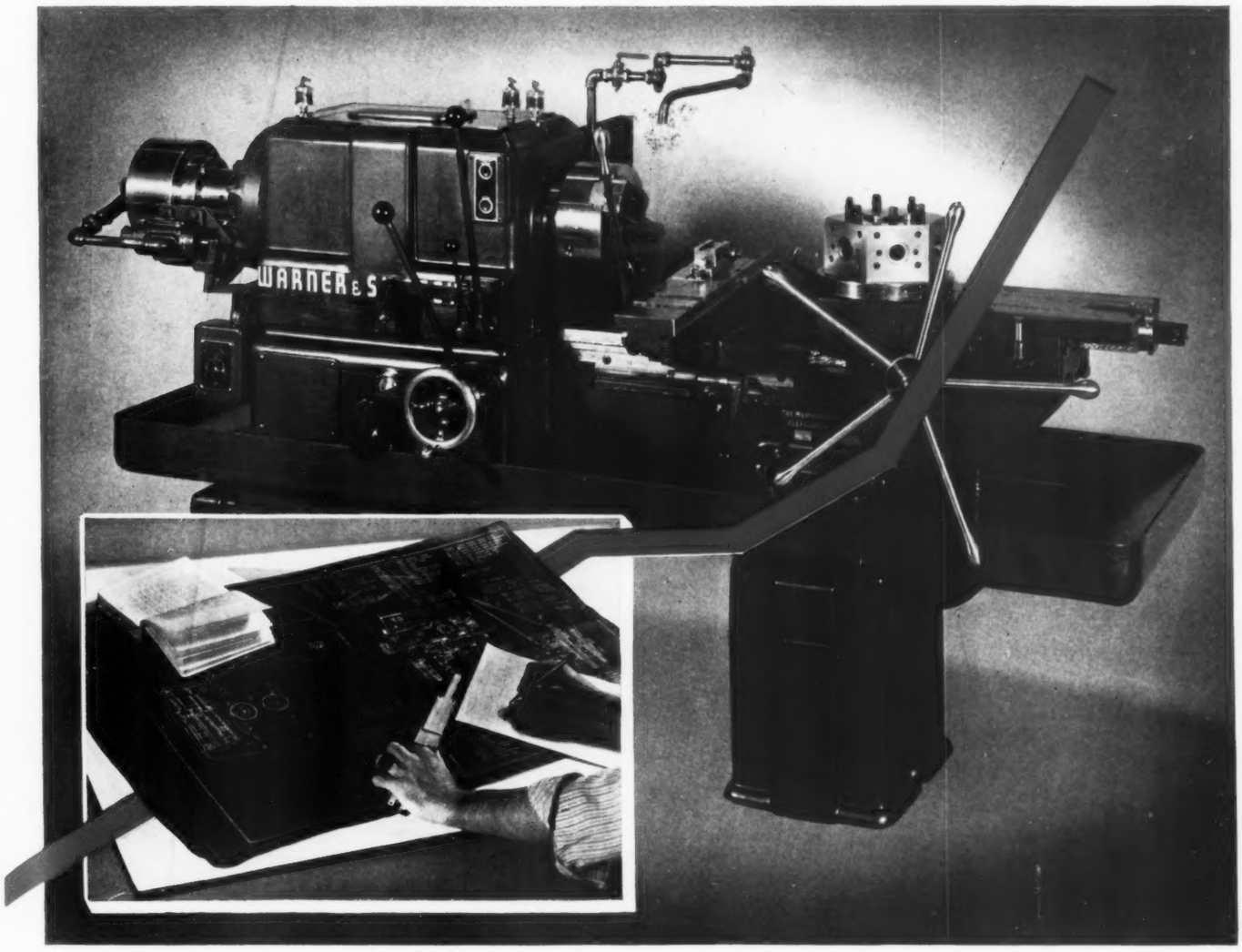
Additional refinements in the design of the hydraulic system have been developed both as the result of the experiences of the machine tool designers and the suggestions from the manufacturers of hydraulic units. As an example, in the design of the broaching machine, the size of the hydraulic piping as it approaches the oil reservoir is gradually increased in order to reduce to a minimum the velocity of the oil as it enters the reservoir in order to minimize the possibility of emulsifying the oil. For the same reason, the ends of the return pipes are placed well below the lowest level of oil in the reservoir, the connections to the reservoir being made at the end opposite to the pump suction so as not to interfere with the suction of a solid column of oil.

In high-precision machines such as broaches and grinders, the oil reservoir is placed outside the machine frame or is well heat-insulated from the frame of the machine to prevent changes in temperature of the hydraulic oil from causing localized thermal expansions that might impair the accuracy of the machine. Similarly, one designer put flexible couplings in his control shafts so that unequal expansions of the parts that carry the control-shaft bearings will not cause the shaft to bind.

To make maintenance easier, many designers have placed motors and hydraulic pump control units in more accessible positions.

Motors with glass insulated windings, while developed primarily for driving





machines where ambient temperatures are high, offer in addition weight and space saving advantages where motors are built into the machine. In these instances, glass insulation can often be used on motor windings in preference to other Class B insulating materials.

A few machine tool builders are using in their machines motors having rotors with centrifugally cast copper end rings and incased laminations. It is claimed that these motors are especially adapted to the severe service encountered in plugging or reversing duty, which demands mechanical strength at abnormal temperatures.

Built-in lighting fixtures are becoming more popular as evidenced by the increased number of machines that have adopted this design feature. Some machine tools have two lamps in order to eliminate shadow. At least one milling machine, Kearney & Trecker, has separate lamps to illuminate each dial. And in all instances the lighting fixture is designed special for that application, of course using as many standard units as possible.

For improved lubrication a great many machine tool builders use synthetic rubber wipers for keeping clean the ways, guides and similar sliding surfaces. For wiping the bed ways of turret lathes one manufacturer uses a spring tension device with a felt wiper. The spring wiper is made of bronze properly tempered to obtain a spring effect while moving over the bed way. The spring wiper has a tendency to scrape, without scratching, hard particles such as grindings or shavings from the ways. A felt wiper in the assembly mops up and absorbs water or coolant.

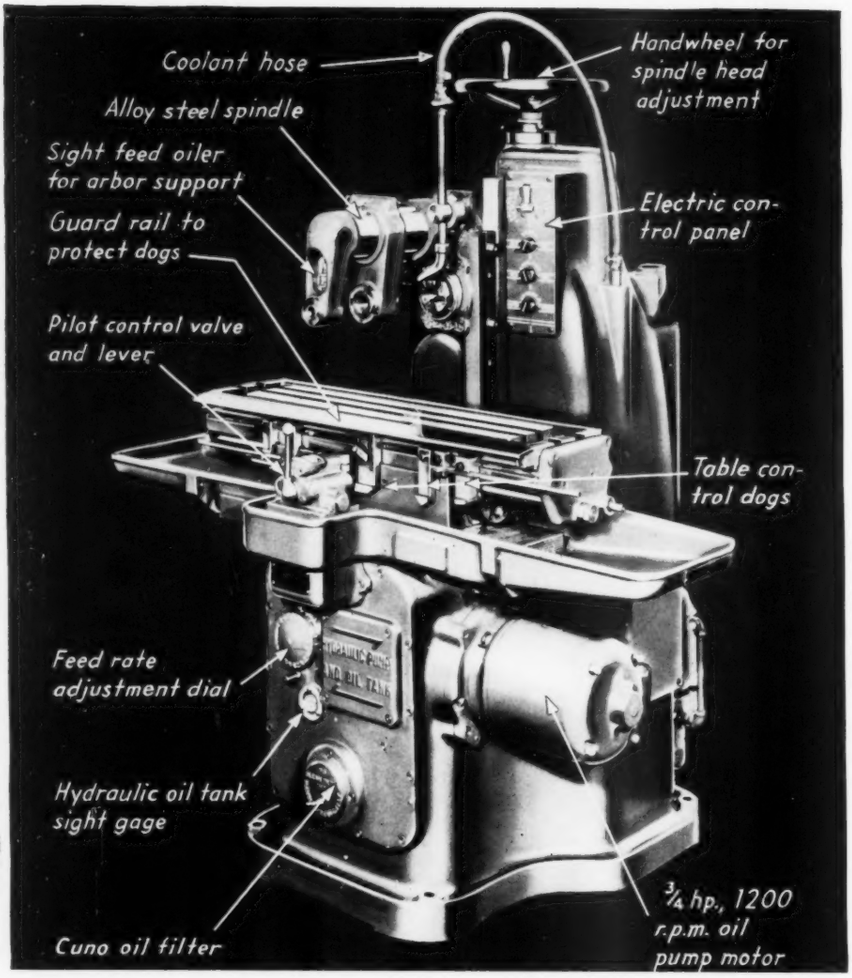
Numerous other refinements are also found in the various designs of lubricating systems.

Practically all machine tools make use of oil filters for keeping the lubricating oil clean; almost all have forced-feed lubrication by means of a central pump or pump lubricators actuated by the movement of one of the machine elements. In the application of filters, at least one machine tool designer drives the filter cleaner continuously off an eccentric on one of the shafts of the machine in order that the operator need not be required to clean the filter occasionally by turning the cleaner crank by hand.

Flame-hardening and nitriding are being adopted by a great many designers. At least a dozen machine tool builders are using flame hardening to obtain hardened ways. Several machine tool builders specify the gears to be flame hardened, this giving hard wear resisting teeth without sacrificing core toughness or running the risk of warpage. In many instances spindles and bushings are hardened by nitriding in order to avoid any possibility of warpage such as might occur if parts were to be case hardened or through-hardened.

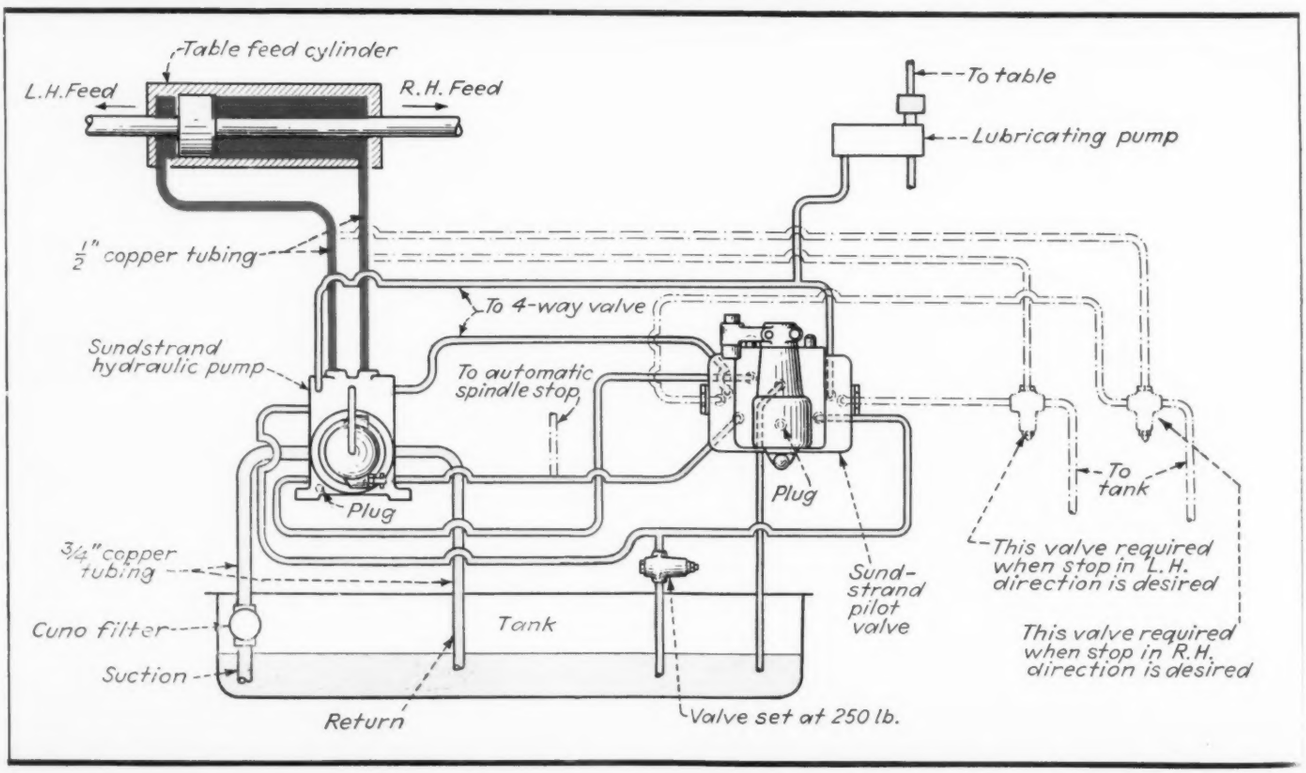
One chief engineer has gone into the extensive use of laminated shims to facilitate the accurate locating of bearing shoulders. By the use of shims it becomes unnecessary to machine the frames or housings to an extreme degree of accuracy, nor is it necessary to locate the shoulders on shafts with a high degree of precision. By using laminated shims the shafts are mounted readily to the exactly desired tightness of fit and it is reliably reported that considerable savings in machining costs are effected.

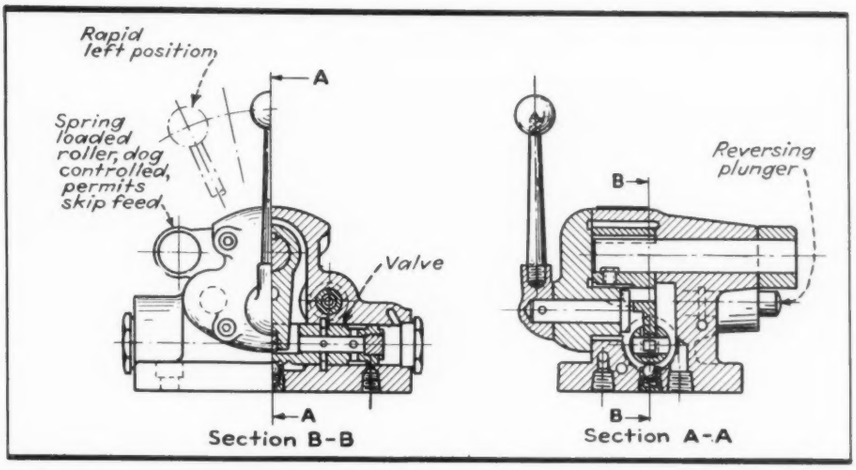
Hydraulic Feed for Production Milling Machine


Coolant hose
Handwheel for spindle head adjustment
Alloy steel spindle
Sight feed oiler for arbor support
Electric control panel
Guard rail to protect dogs
Pilot control valve and lever
Table control dogs
Feed rate adjustment dial
Hydraulic oil tank sight gage
Cuno oil filter
¾ hp., 1200 r.p.m. oil pump motor

Hydraulic automatic table feed and control, automatic spindle stop, Bijur pressure lubrication and Logansport coolant system are features of the Rigidmil production milling machines of the Sundstrand Machine Tool Company. Improvements since the 1935 Machine Tool Show include redesign of gear chains giving a 16 to 1 ratio instead of 8 to 1. The use of lapped and carburized alloy steel gears has become important in order to keep pace with requirements for greater accuracy and better finish. Pilot-valve operated hydraulic control provides uniform table feed, variable from ½ to 38 in. per min. Drive to the spindle is through adjustable V-belt from the 1 hp., 3,600 r.p.m. spindle motor.

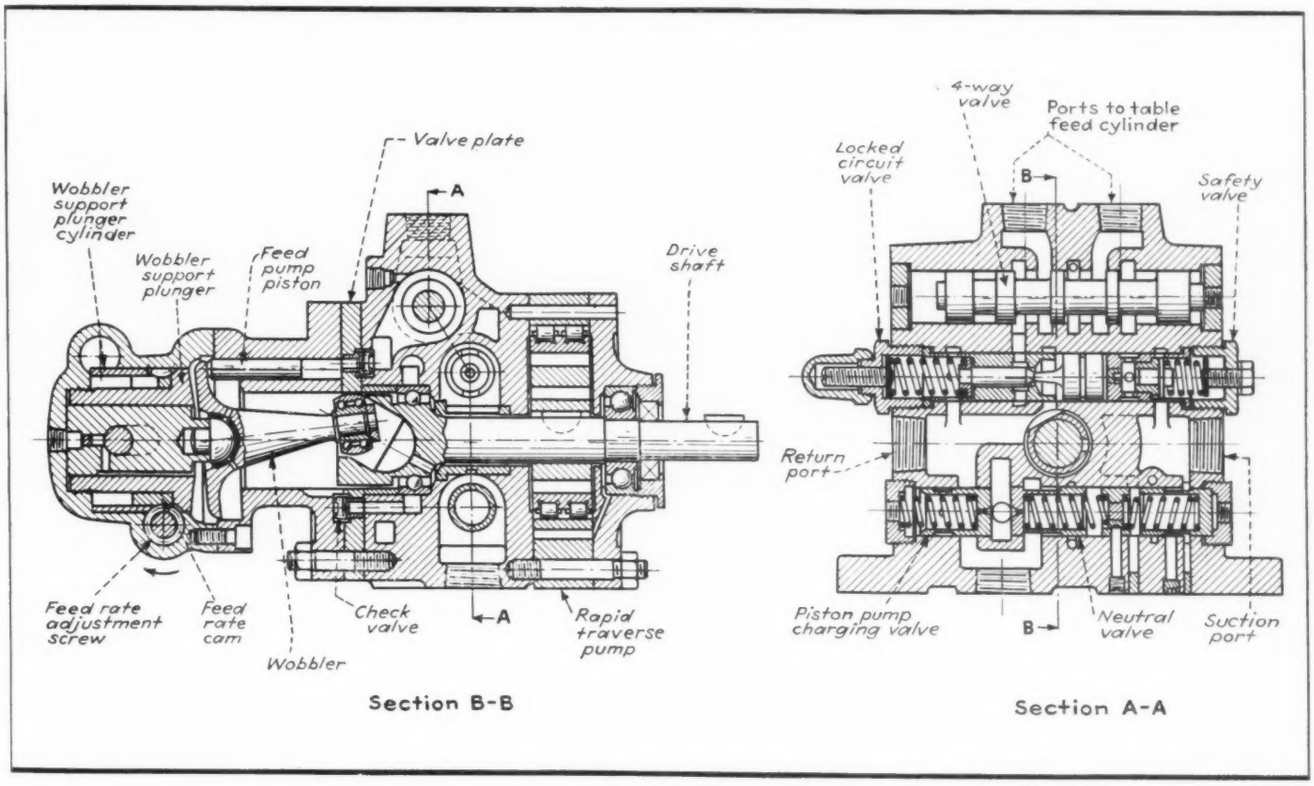
Hydraulic piping diagram shows method of connecting Sundstrand oil pump, pilot valve and table feed cylinder in the hydraulic circuit. Five pipe lines to pump are the main valve control lines from the pilot valve, operating on oil at low pressure. In the feed circuit, the hydraulic oil is taken to the pump through the Cuno oil filter at the lower edge of the pump control panel. Four-way valve in top of pump housing, controlled by pilot valve, directs oil from pump through pipe lines to the table feed cylinder to produce rapid traverse or feed motion in the proper direction. Pressure in the actuated cylinder, sufficient to overcome the resistance of the cut, varies with this resistance.





Pilot valve, located in central operating position in front of table, provides manual and automatic control of table movements. Automatic control of the valve by dogs attached to the front of the machine table makes available nine different table cycles, involving automatic start, feed, rapid traverse, and stop. When the machine is in feed, a safety bar for use with the control dogs limits the movement of the manual control lever to either reverse feed or rapid return. It is impossible for the control lever to be accidentally moved from feed to rapid advance while the cut is in progress unless skip feed is provided.

Valve stem in the pilot valve is attached to the manually operated handle and to the dog actuated valve arm. Moving either carries the valve stem to one of five positions. When centered, neutral occurs. Moving valve one notch in either direction causes table feed in that direction, and when moved to second notch, rapid traverse in the same direction occurs. The two dog-operated plungers are used to provide automatic table reverse. With standard reversing dogs, the table will reverse within plus or minus 0.01 in. A valve mechanism for automatic reverse and accurate stopping of the table within limits of plus or minus 0.001 in. can be supplied. Overtravel of the table can be prevented by setting the adjustable positive stop. A guard rail on the table protects the dogs and prevents accidental changes in settings.

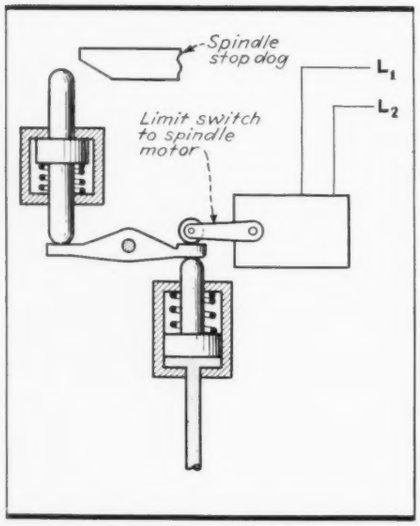


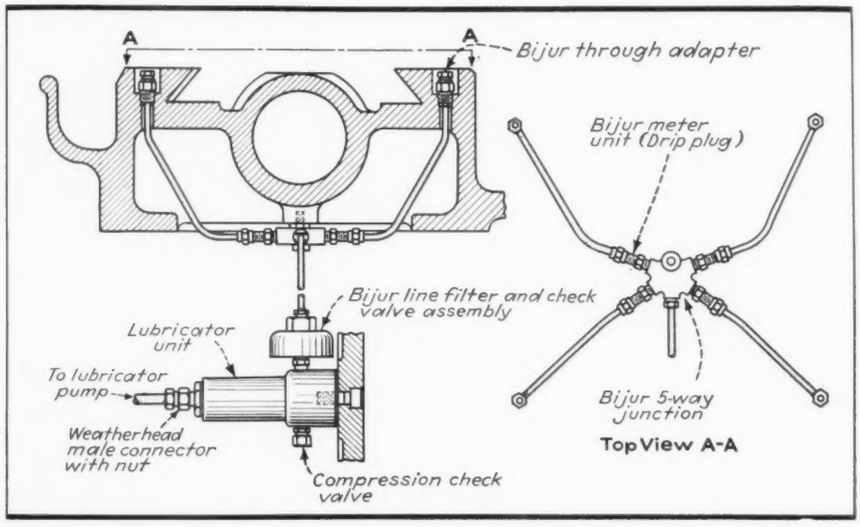
Hydraulic feed unit. A constant displacement rapid traverse pump, a variable displacement piston feed pump, and the valves controlling the action of these two pumps are all contained in the pump housing mounted to the control panel inside the base of the machine. Pump is coupled to the ¾-hp., 1,200 r.p.m., flange-mounted feed motor at the right hand side of the base of the machine.

Feed pump is of the wobbler type with five pistons, capacity 0.72 gal. per min. Rate of feed can be adjusted between ½ and 38 in. per min. by turning the feed rate adjusting screw to shorten the eccentricity of the pump wobbler. Feed dial, graduated in in. of feed per min., is geared to the screw. Rapid traverse pump is a rotary pump consisting essentially of an external rotor, internal roller and crescent, with a capacity of 6 gal. for the No. 0 Rigidmil; 8-gal. for the No. 1 Rigidmil. Hydraulic cycle is controlled by valves contained in the port housing, these valves in turn being controlled by the pilot valve. The four-way valve, mounted in top of housing, controls the direction of oil flow to the actuated cylinder. The piston pump charging valve serves to charge the non-priming piston feed pump, and allows oil from the rapid traverse pump not used by the piston pump to return to the tank during feed. Oil from the rapid traverse pump is discharged by the neutral valve to the tank during neutral. The safety valve acts as a relief in case of overload and determines the maximum pressure at which the circuit will operate. Back pressure on the return oil from the cylinder is produced by the locked circuit valve.

(Continued on next page)

Hydraulic Feed for Production Milling Machine *(Continued)*



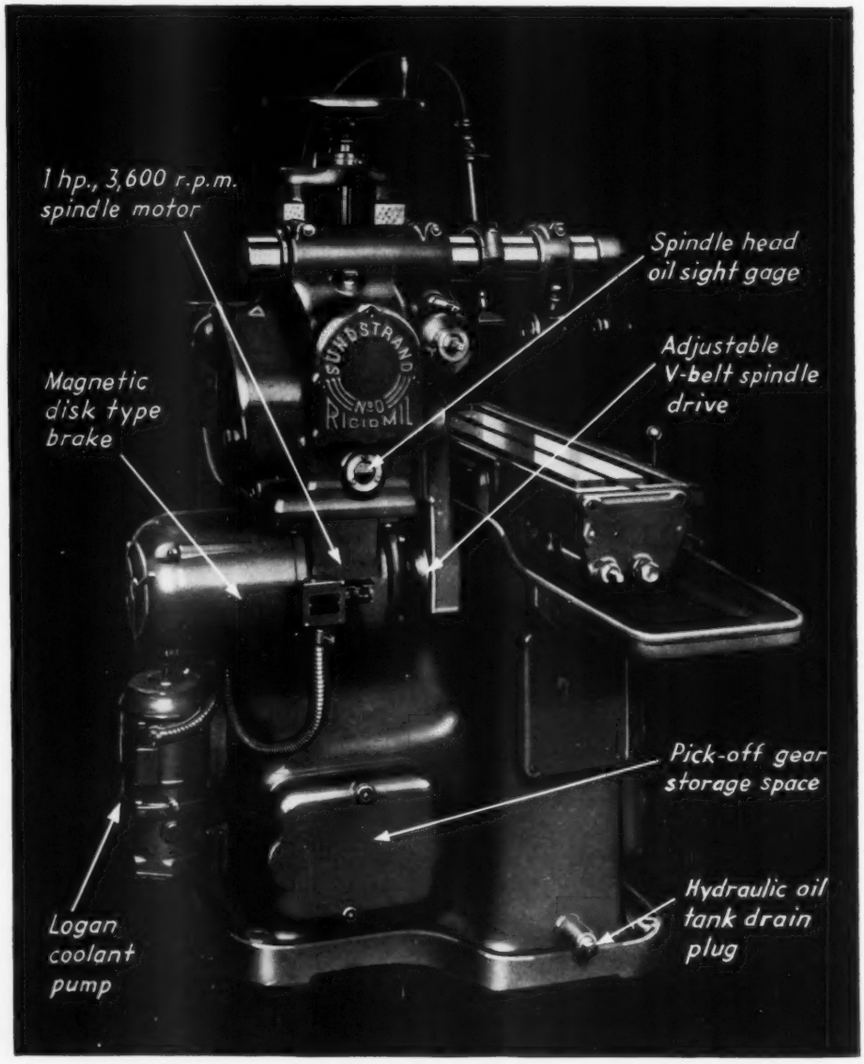


Automatic spindle stop, furnished as an extra, permits the spindle to rotate only during the feed stroke. The unit consists of an electric limit switch, hydraulic cylinder, piston, and a tappet rod, all mounted in the machine column behind the hydraulic control panel. Cylinder is connected to line running from pilot valve to pump. Built-in magnetic disk brake, with braking torque as much as 2½ times the motor torque requirements, brings the spindle to a quick stop when the spindle motor is shut off. At the end of the table cycle, the spindle stop dog depresses the tappet rod to open the limit switch, cutting off current to motor. During the rapid approach and rapid return of the table, the limit switch is held open by the hydraulic piston.

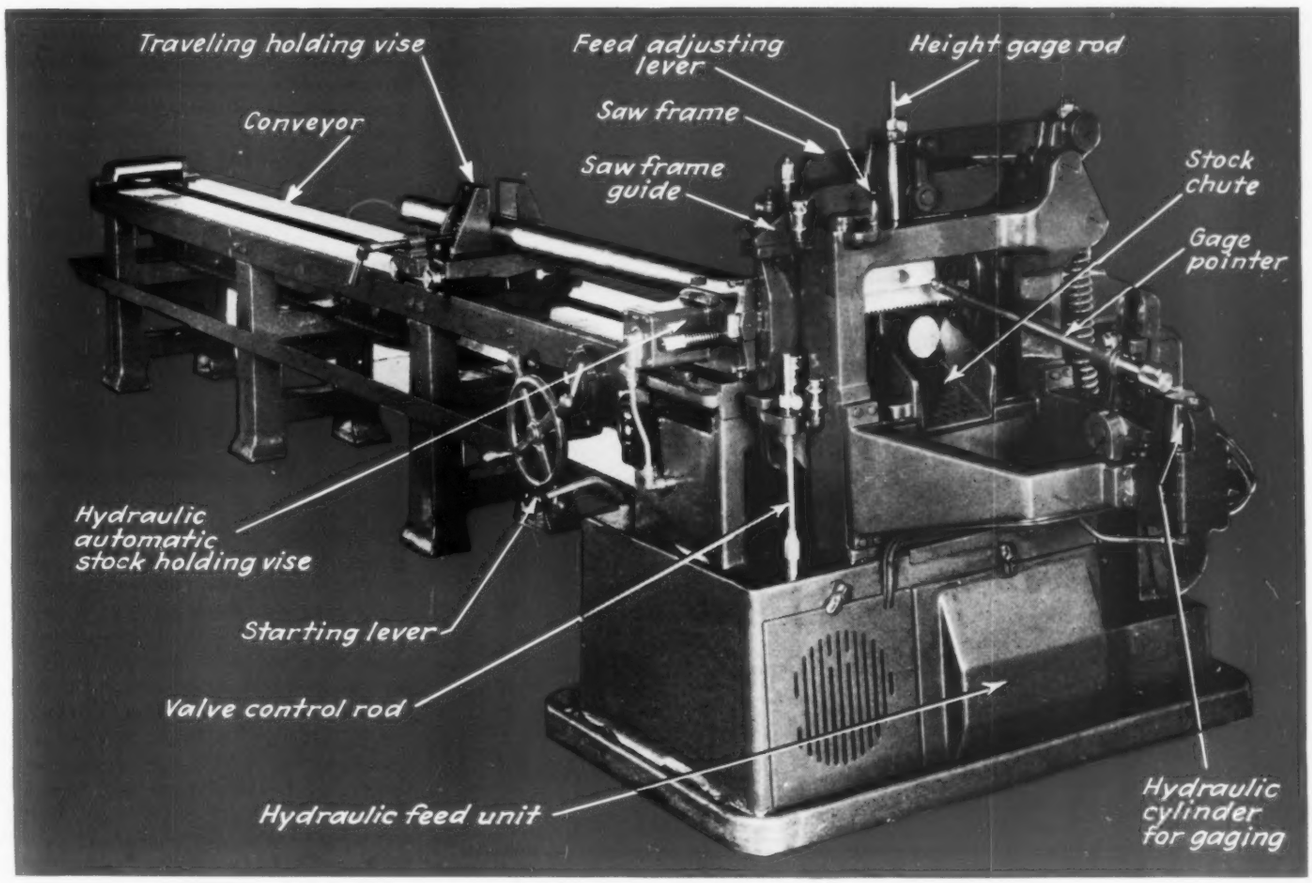
Coolant pump. Furnished as extra equipment is a "Logan" pump of the individual motor driven impeller type mounted at the rear of the machine base, capacity of 5 gal. per min. When coolant is not required, the flow can be stopped by switching the button on the control panel to "off." With the button at "on" the flow will automatically start and stop with the machine spindle. Variable-flow valve nozzle is adjustable in the bracket mounting on the overarm.

Electric control panel, conveniently located at the front of the column, contains switches for hydraulic pump, spindle motor, and coolant motor. Direction of rotation of the spindle is controlled manually by the lever at the top of the panel. Main feature of the wiring is the complete interlocking of the electrical system. Overload relays are in series so that all motors will stop if one becomes overloaded. Spindle will always run when the table is feeding. Starters for motors are mounted in a compartment in the rear of the column.

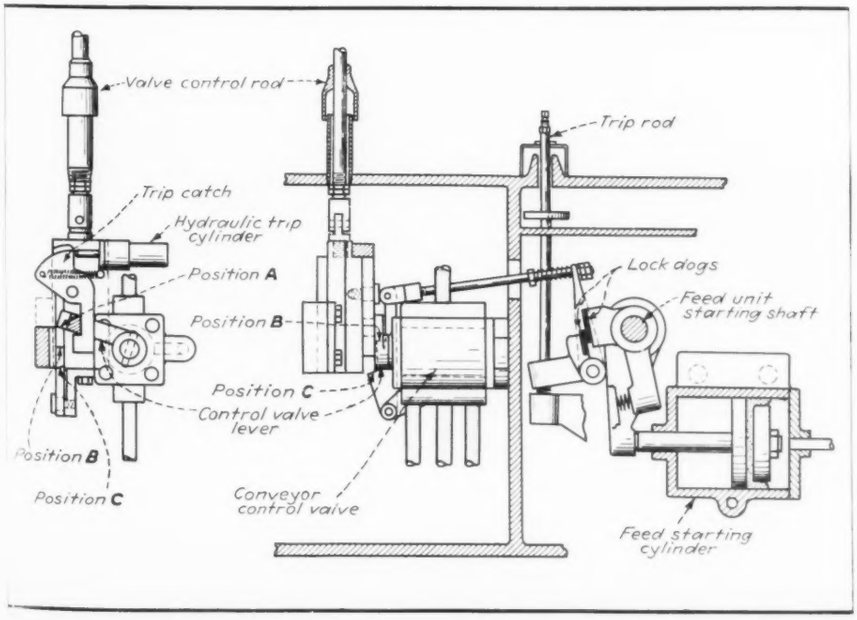
Table lubrication is taken care of automatically by the hydraulic system through Bijur pressure lubrication fittings. Lubricator pump, operating directly from line to pilot valve, supplies oil to lubricator unit, line filter and check valve assembly. From here, the oil is fed to a five-way junction, which distributes it to the four points shown. Spindle head is lubricated by the splash system from a separate oil reservoir. Sight feed oiler lubricates arbor support.



Production Saw Has Hydraulic Automatic Control



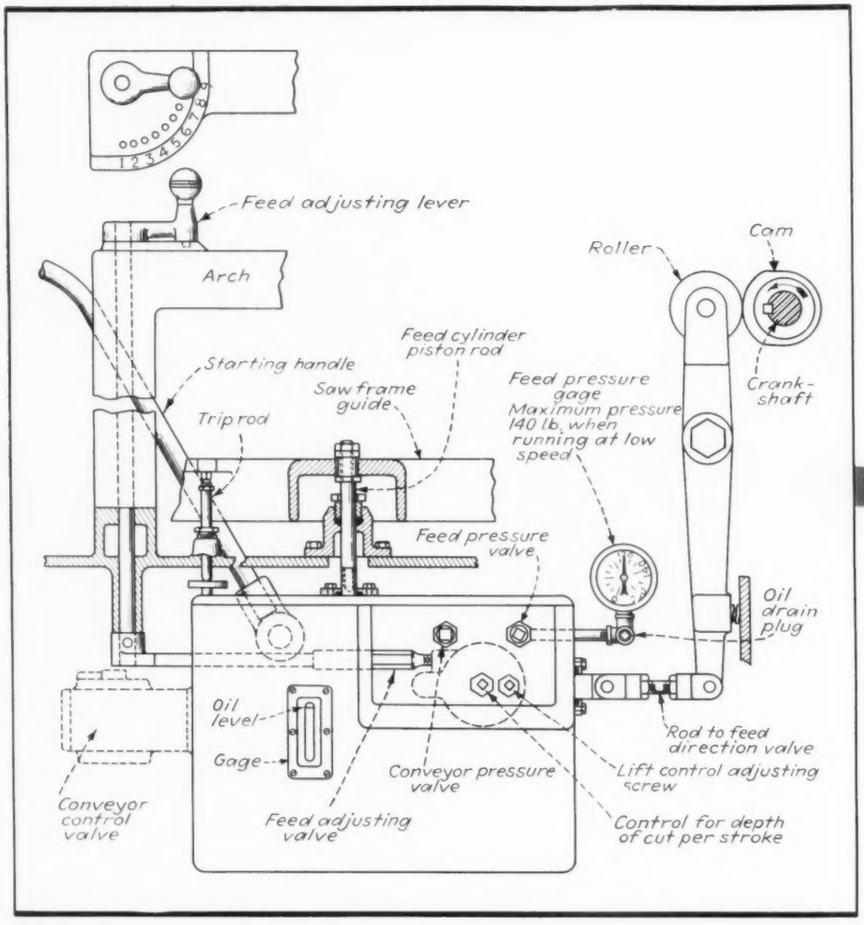
Hydraulic system for applying cutting pressure and returning saw to starting position, hydraulic stock feed conveyor, hydraulically actuated stock gage, and work clamp make this metal saw of Peerless Machine Company a completely automatic production machine. Base and main frame are semi-steel castings. Rigid saw frame moves transversely in the saw frame guide, frame and guide moving vertically as a unit. Bearings for these motions are Gunite shoes riding in rectangular ways lined with hardened steel strips. All rotating shafts in machine run on anti-friction bearings. When automatic lubrication is not used, Gits wick feed oilers are placed at bearing points. Single push button station controls motor. Machine automatically shuts off when travelling vise reaches end of travel.



Control valve lever is lifted to *A* when the saw frame is up in starting position; this movement opens ports to stock gage cylinder and feed cylinder, and discharges oil from vise cylinder to release the stock. When stock is moved by conveyor against gage rod to actuate hydraulic trip cylinder, the trip catch is moved back and control valve lever falls to position *B*. This automatically opens ports to vise clamping cylinder to clamp stock securely, and exhausts gage and conveyor cylinders. Feed starting cylinder piston rod now resets trip dogs, engages the feed unit and starts the cut. When trip dog falls into position, it allows control valve lever to drop into position *C*, exhausting and permitting return of starting cylinder piston. At end of cut, saw frame contacts trip rod, releases trip dog, and is automatically returned to starting position.

(Continued on next page)

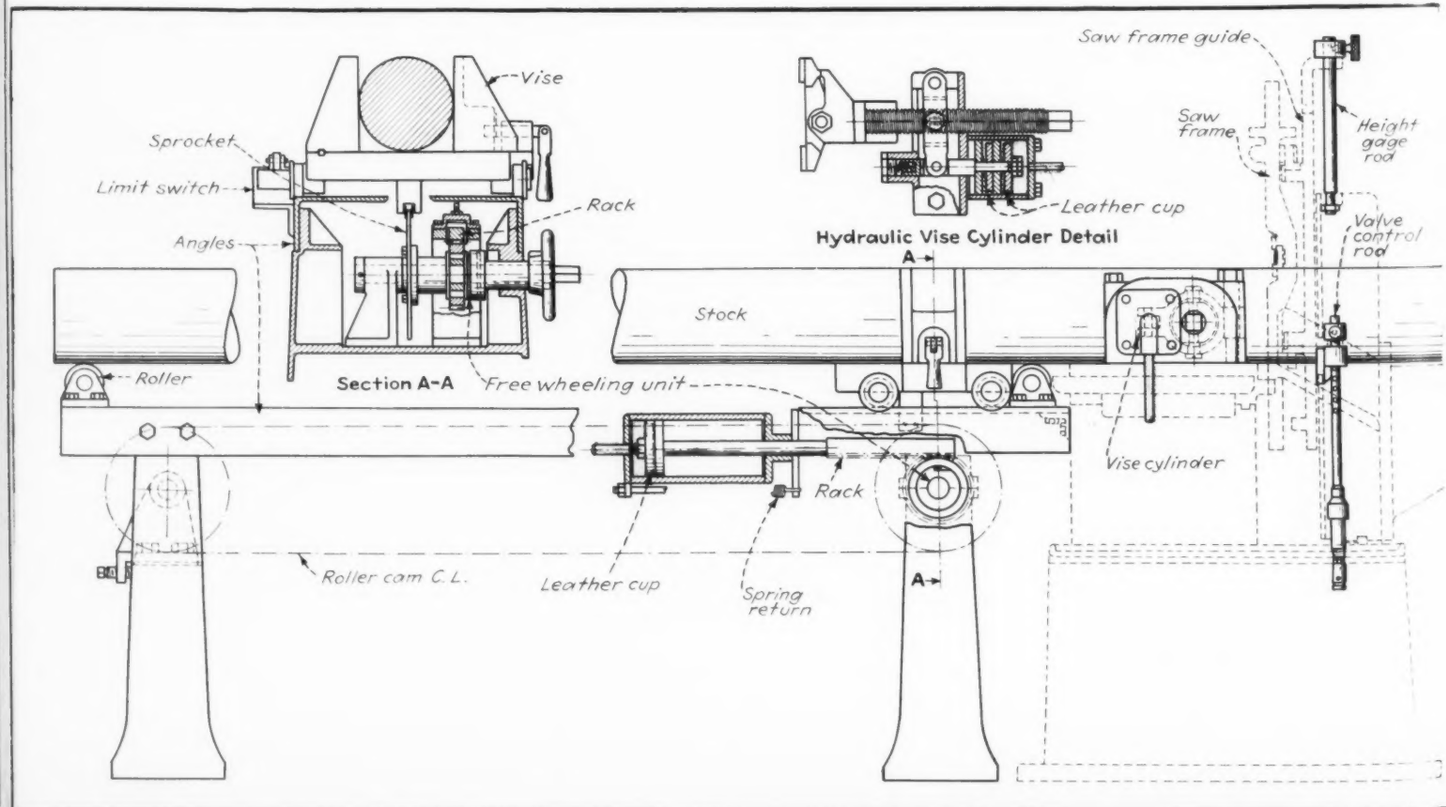
Production Saw Has Hydraulic Automatic Control (*Continued*)



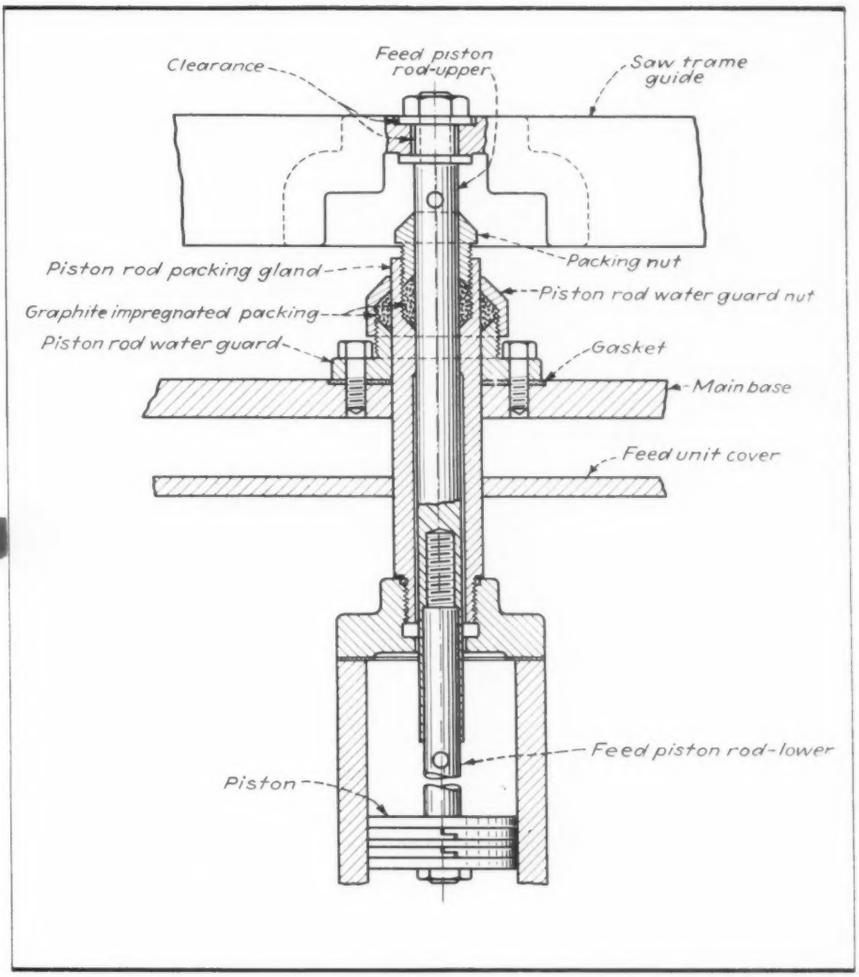
Feed unit provides adjustable control of feed pressure and lifts saw slightly on return cut. A cam on the crankshaft actuates a roller and lever which reverses feed valve, reversing feed cylinder motion to create pressure downward on cutting stroke, and pressure upward for return stroke. Feed control valve is adjusted by feed adjusting lever, making available nine different feed pressures ranging from 160 lb. per sq. in. to 450 lb. per sq. in. Lift of the saw blade on non-cutting stroke can be adjusted by the lift control adjusting screw. Depth of cut per stroke, set at the factory for 0.05 in., can also be adjusted by set screw for cutting thin walled stock.

All units of machine

Hydraulic cylinders, actuated in proper sequence by control valve, operate bar holding vise, bar feed conveyor and gaging rod. Rolling vise of conveyor is fed forward by roller chain, sprocket of which is moved by hydraulic cylinder through rack and pinion. When bar feed operations are started, hydraulic cylinder lowers gage rod. Stock, fed forward until it pushes against end of gage rod, causes trip finger to open trip valve to actuate hydraulic trip cylinder in control valve mechanism. Motor is a constant-speed 1,800 r.p.m. motor, 2 hp. where

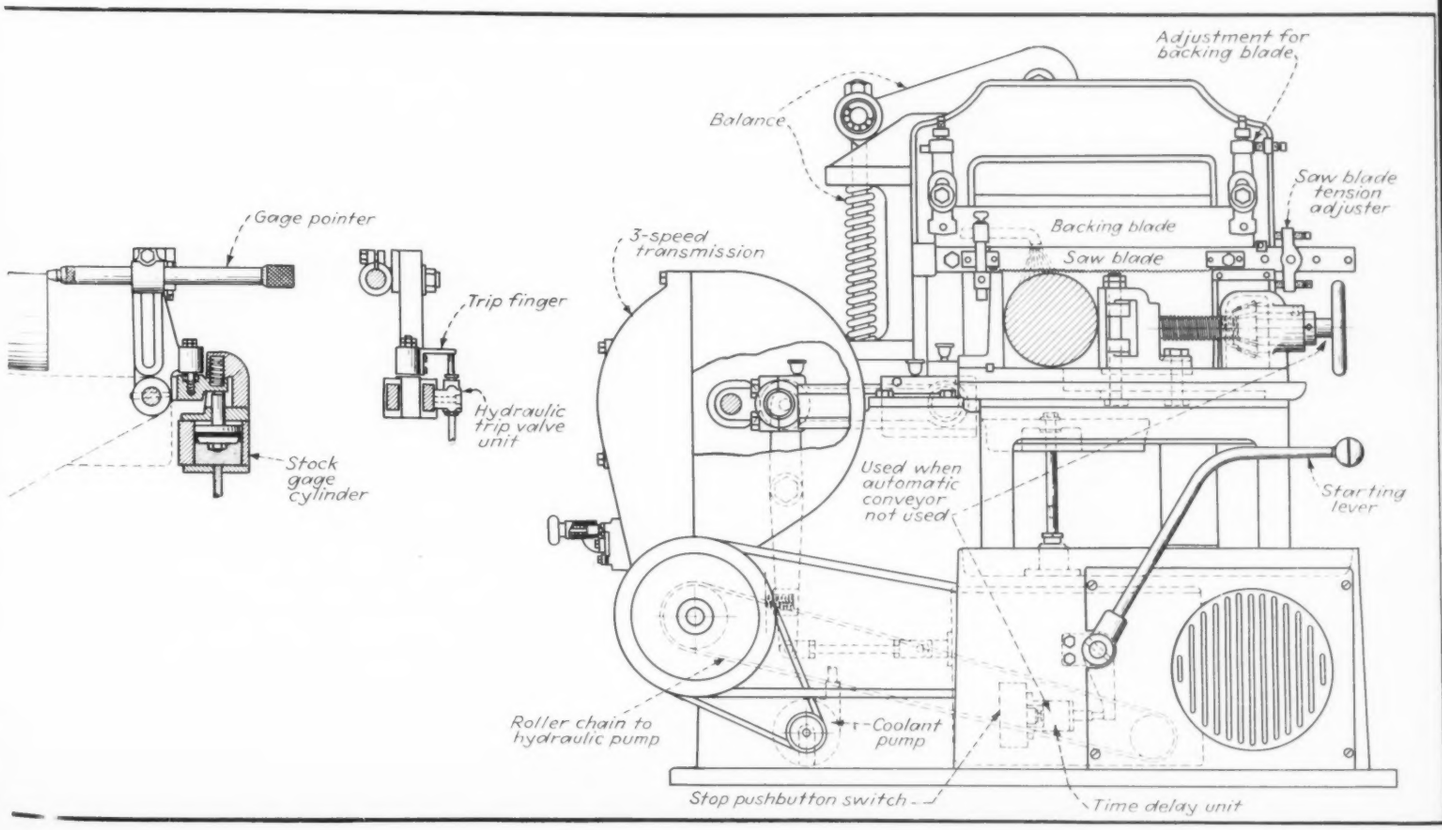


Vertical feed is by hydraulic cylinder and valve controls mounted as a unit in the oil sump. Cylinder applies downward pressure while the saw is cutting, release pressure while the saw is returning, and a rapid return to top of travel when cut is completed. Cylinder and piston rod are protected from action of soluble coolant by graphite impregnated packing held in packing glands. Since cylinder and entire hydraulic unit is installed as one unit, a long piston rod would make assembly difficult, therefore, the rod is made in two parts as shown, the top part being screwed to the lower rod after hydraulic unit is placed inside frame. Allowance is made for slight lateral movement at connection of piston rod and saw frame guide.

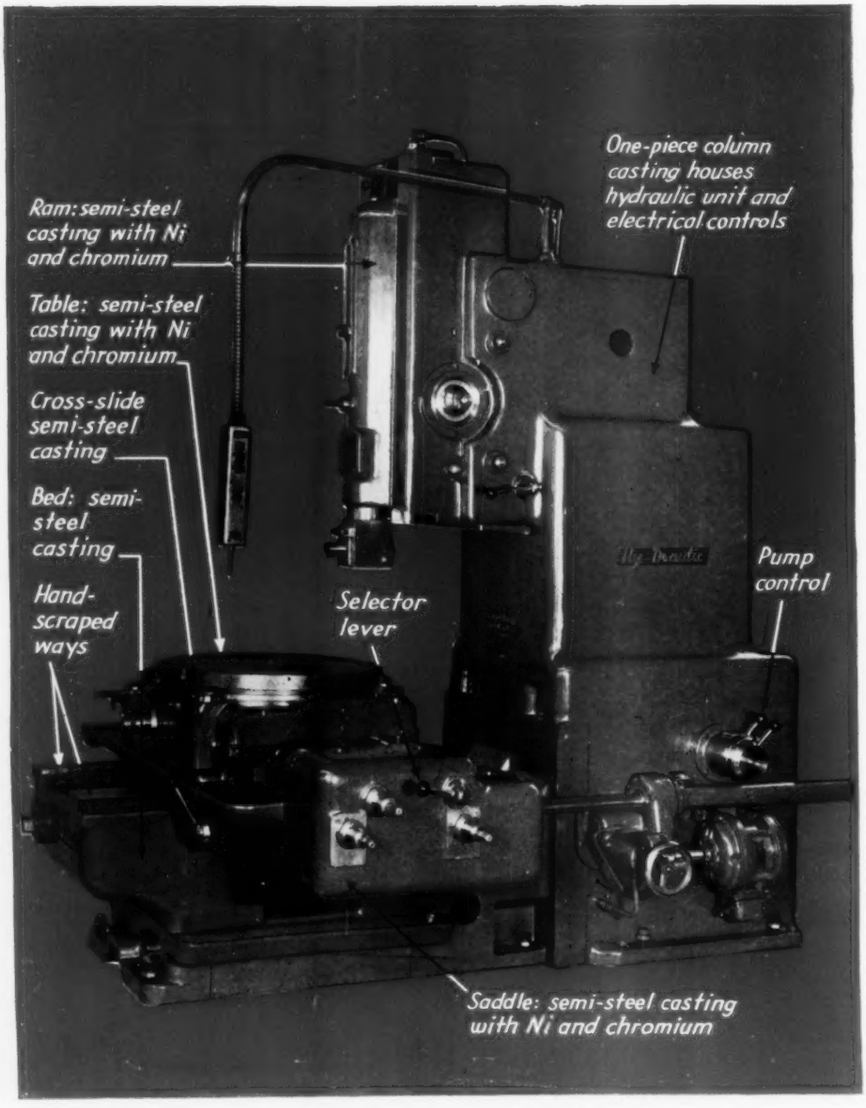


driven by one motor

automatic bar feeder is used, 1½ hp. when bar feed is not used. Motor drives three-speed sliding gear transmission through V-belts. In saw frame drive, heavy bull gear connects transmission to crankshaft and connecting rod, providing flywheel effect. Connecting rod has bronze bearing at crankshaft end and Bantam roller bearing at saw frame end. Motion at this point is so small that needle type bearings are used to avoid hardening. V-belt from pulley shaft drives coolant pump; chain and sprocket drives gear type hydraulic pump.

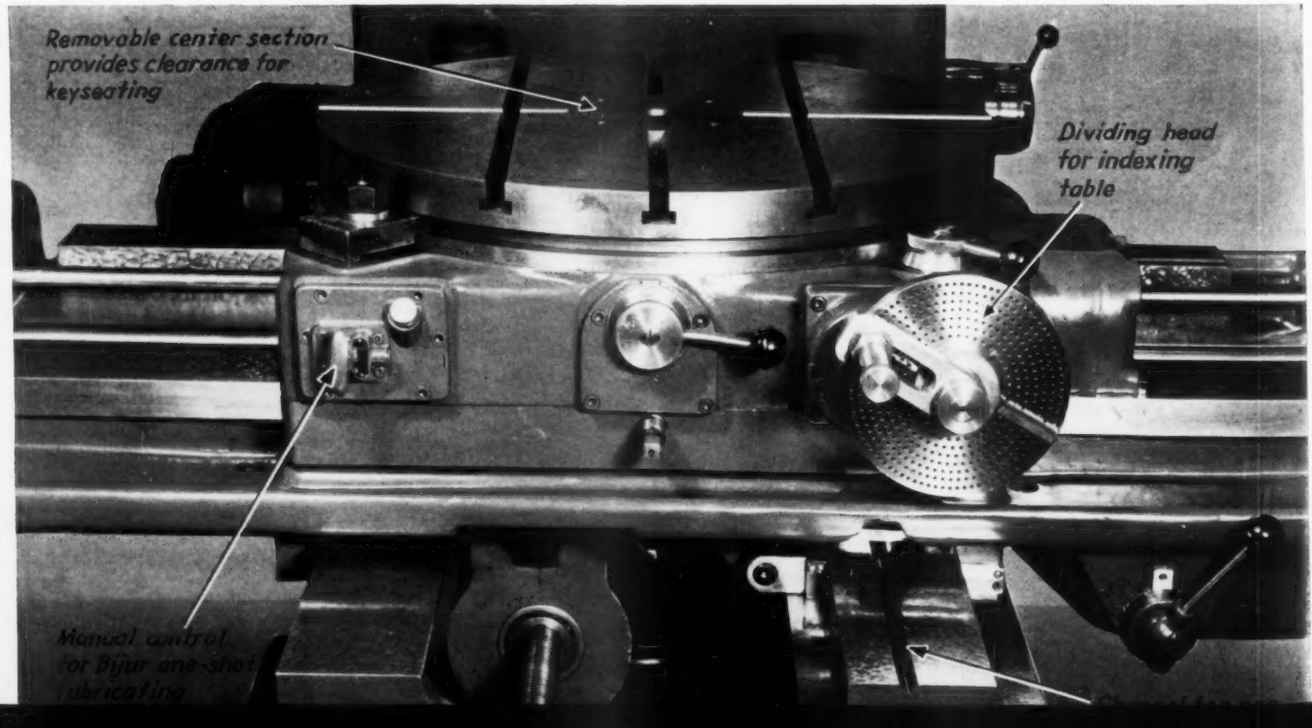


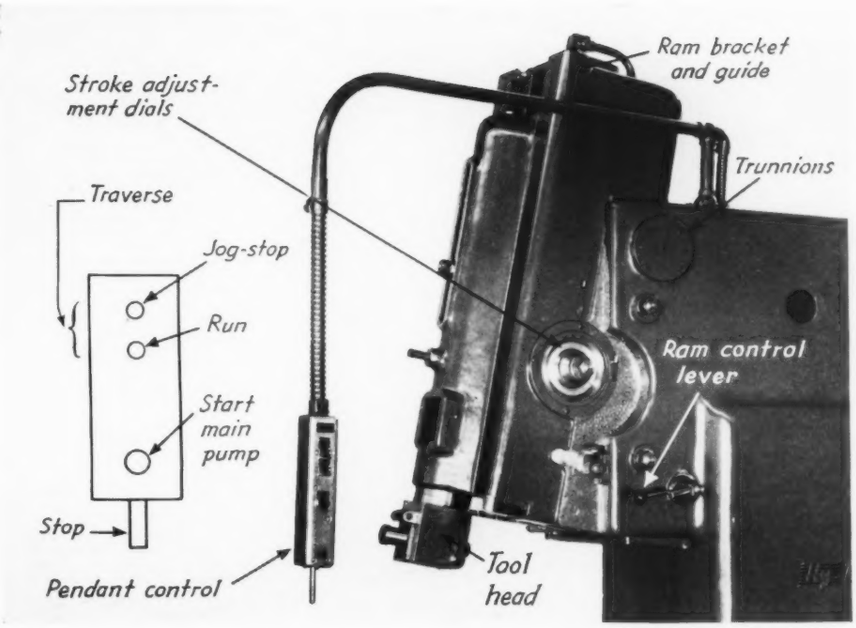
Ram and Table Feed Hydraulically-Actuated

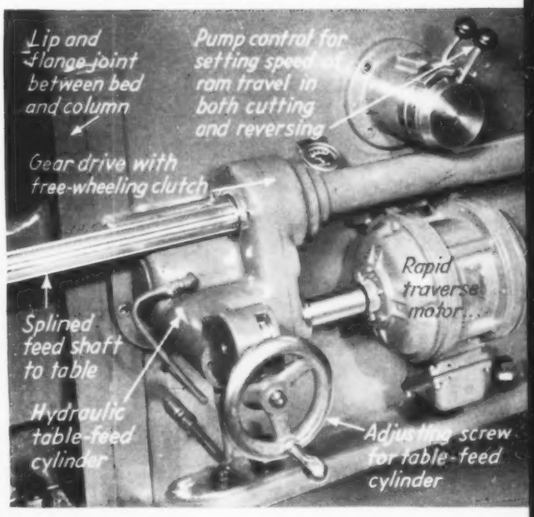

One-piece column casting houses hydraulic unit and electrical controls
Ram: semi-steel casting with Ni and chromium
Table: semi-steel casting with Ni and chromium
Cross-slide semi-steel casting
Bed: semi-steel casting
Hand-scraped ways
Selector lever
Pump control
Saddle: semi-steel casting with Ni and chromium

WIDE range of ram speeds and table feed rates are obtained through hydraulic power in the Rockford Machine Tool 12-in. vertical shaper. Ram has 150 strokes per min. at the minimum stroke of one in. Table is provided with micrometer adjustments; provision has also been made for application of precision measuring bars similar to method used in jig boring machines. Column is one-piece, box section set over bed casting with lip and flange arrangement for rigidity and improved alignment.

Semi-steel castings are used throughout the machine. Column casting contains about 40 per cent steel scrap. Saddle casting, which slides on the bed, is brought to 240–250 Brinell by addition of nickel and chromium. Cross-slide casting, which slides on saddle, is 160–170 Brinell, while the table is 240–250 Brinell. Alternation of harder and softer materials prevents galling and permits use of scraped ways integral with castings, saves costly hardening of ways. Bed is used as coolant sump. The 28 in. diameter rotary table is carried on a large-diameter, conical-shaped, scraped bearing surface, pressure lubricated. Table drive is through reduction gearing from a Cone worm engagement with a worm gear mounted at the bottom of the rotary table. A manual one-shot Bijur lubricating unit in the cross slide supplies oil to all bearing and way surfaces of the saddle cross slide and rotary table. Gear boxes and anti-friction bearings are permanently grease packed, as is main table drive gearing.


Removable center section provides clearance for keyseating
Dividing head for indexing table
Manual control for Bijur one-shot lubricating

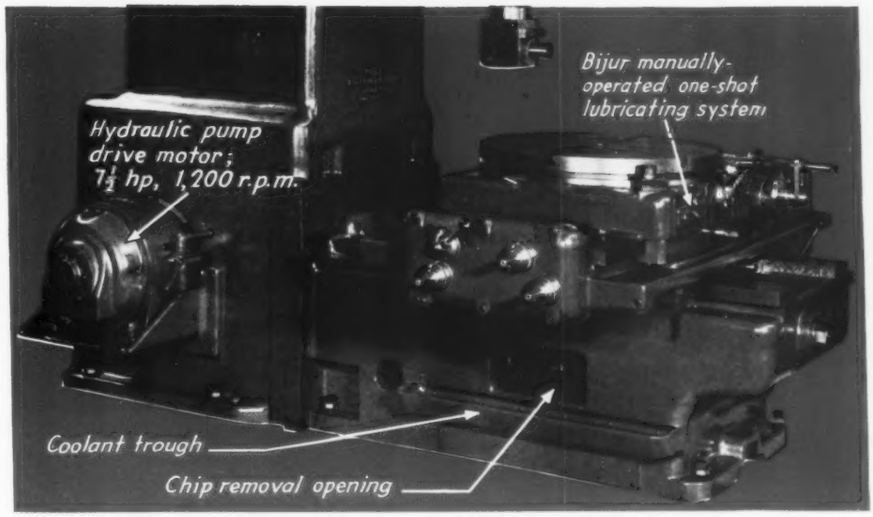


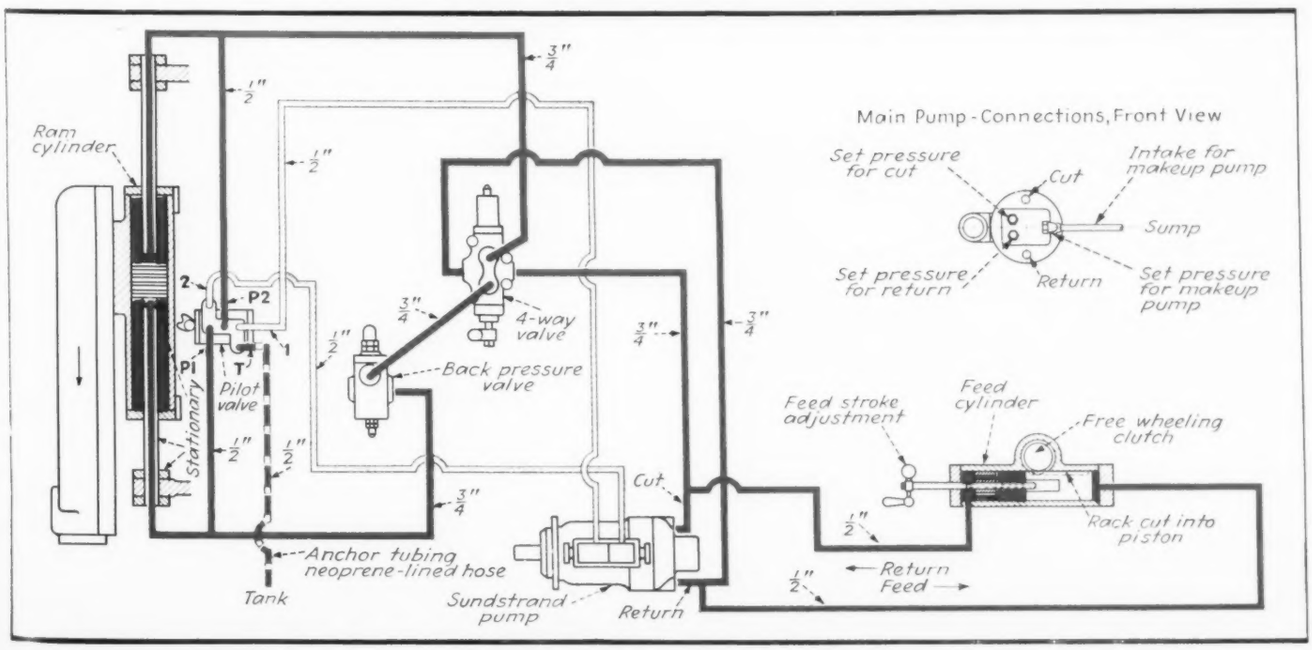

Lip and flange joint between bed and column
Pump control for setting speed of ram travel in both cutting and reversing
Gear drive with free-wheeling clutch
Rapid traverse motor
Splined feed shaft to table
Hydraulic table-feed cylinder
Adjusting screw for table-feed cylinder

Power shaft to table is driven by hydraulic cylinders and gears for slow feed; for fast feed a 1½ hp. motor is used. Gears are Hyten B-3X.

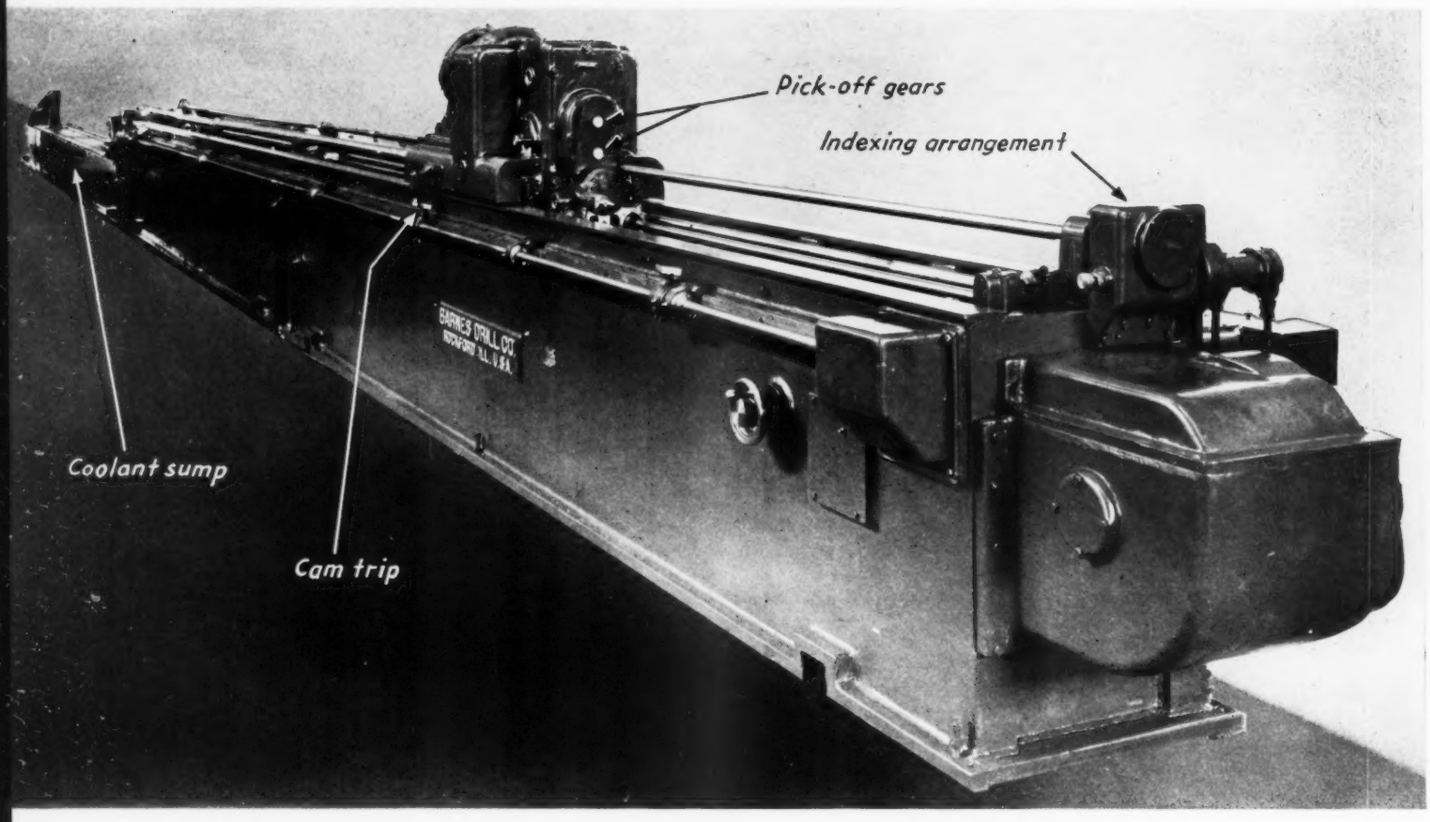
Ram bracket and guide are mounted on trunnions in column and can be tilted a maximum of 10 deg. from vertical. Ram, mounted on heavy-duty, shaper-type ways with adjustable gib in one side, is supplied with constant pressure lubrication from hydraulic circuit.

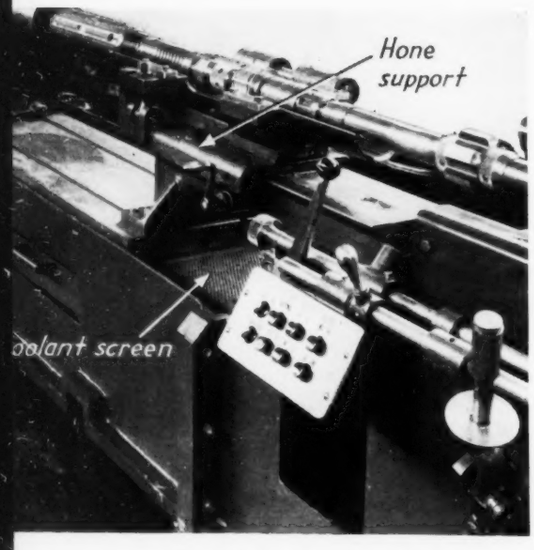
Hydraulic power for ram reciprocation and slow table feed is supplied by a Sundstrand pump driven by a 7½ hp. electric motor. Parker tubing is used for piping. Hydraulic system is a closed circuit. Oil in sump remains cool since 15–20 min. is required for complete turnover. A make-up pump incorporated in the Sundstrand unit replaces oil used to lubricate ram and oil lost by leakage. This constant volume pump delivers one gal. per min. from a 20 gal. sump.


Bijur manually-operated one-shot lubricating system
Hydraulic pump drive motor; 7½ hp, 1,200 r.p.m.
Coolant trough
Chip removal opening



BarnesdriL Horizontal Honing Machines



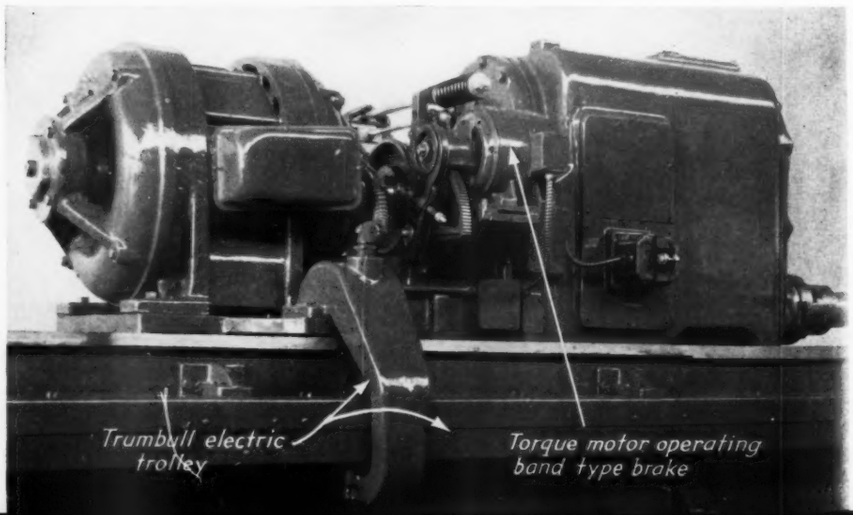


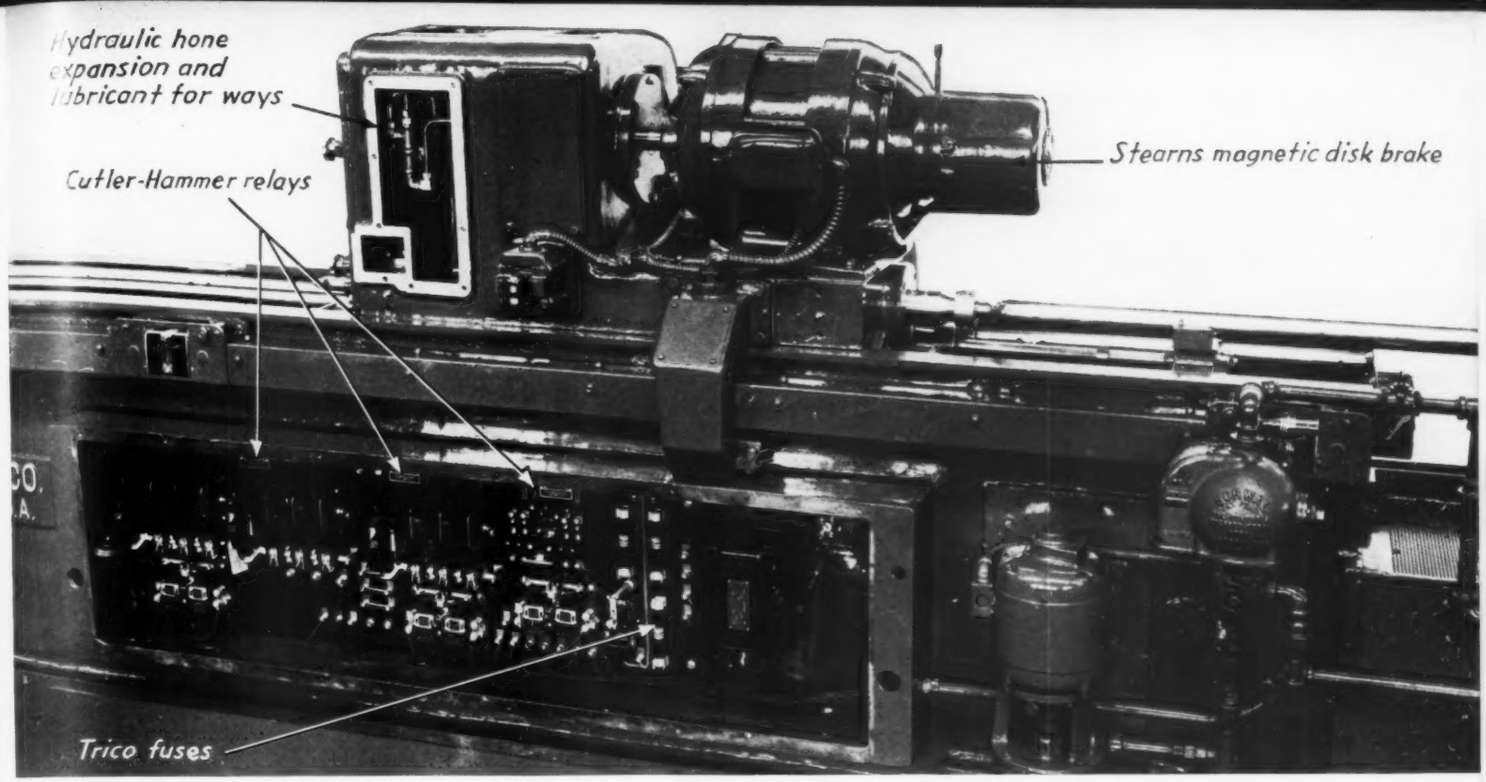
Three methods of spindle braking are used depending on motor size and customer requirements. On motors of 30 hp. or more, a torque motor drives a band-type brake through a pinion and gear segment, as shown. On smaller sizes, Stearns or General Electric disk-type brakes are also used. Torque motor driven shoe brakes are sometimes installed. Trumbull or Ball-Dog type three-phase, covered conduit and trolley arrangement supplies current to motors in reciprocating head, replacing the retracting electric cable previously used.

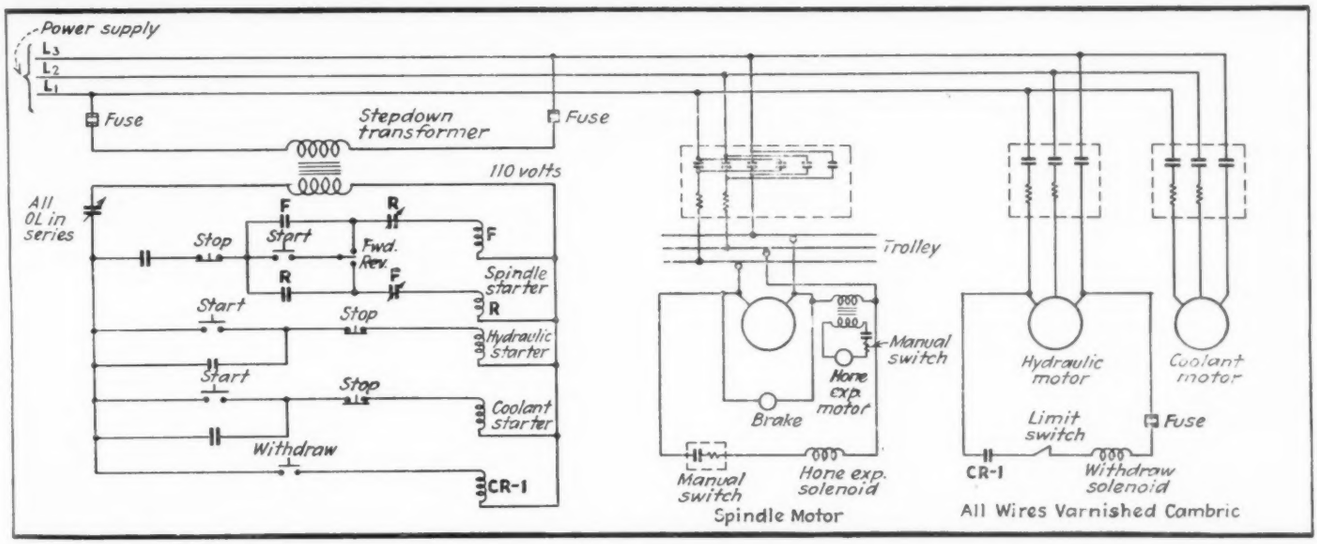
Bases are made in two sections of welded structural shapes and plates, stress-relieved before machining in the Barnes Drill horizontal machines. One section of base supports reciprocating head, hydraulic reciprocating mechanism, controls and miscellaneous parts. Work supporting table, usually the shallower of the two part base may be sunk in floor when honing very large diameter bores. This part of base also serves as coolant sump. Traveling carriages on external machines are welded.

Moving carriage of smaller size internal honing machines rides on round bars; in larger sizes round bars with ground flats for bearing surfaces are provided. Flame hardening is being adopted experimentally for these flat surfaces. Weight of the reciprocating carriage is kept low by making it an aluminum alloy casting, thus reducing inertia.

Standard 3-phase electric motor drives the hydraulic pump which supplies pressure to the fluid motor actuating reciprocating head. Another motor drives the honing spindle through gearing. When a hydraulic expanding hone is used, a separate single-phase motor drive and hydraulic unit is mounted in the sliding head. This motor continues to drive the hydraulic pump in one direction regardless of direction of spindle drive motor rotation. The Allis-Chalmers coolant pump is also a separate unit and is recessed in the machine base.



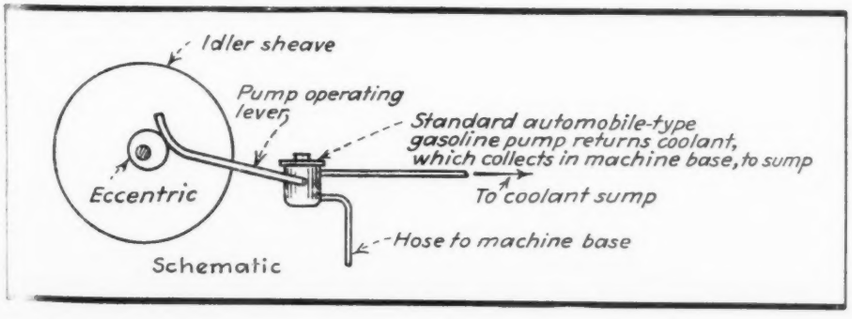


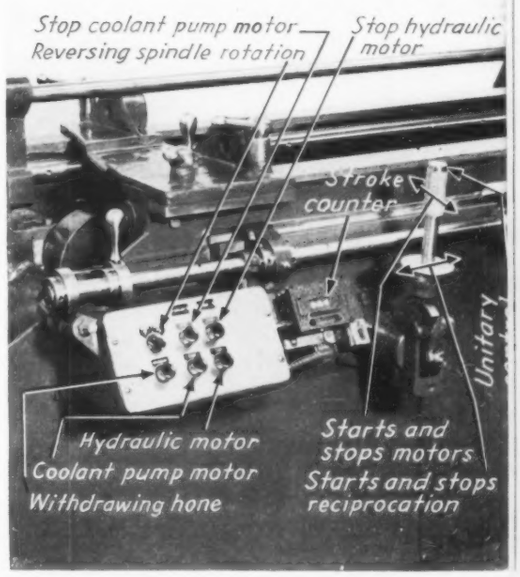


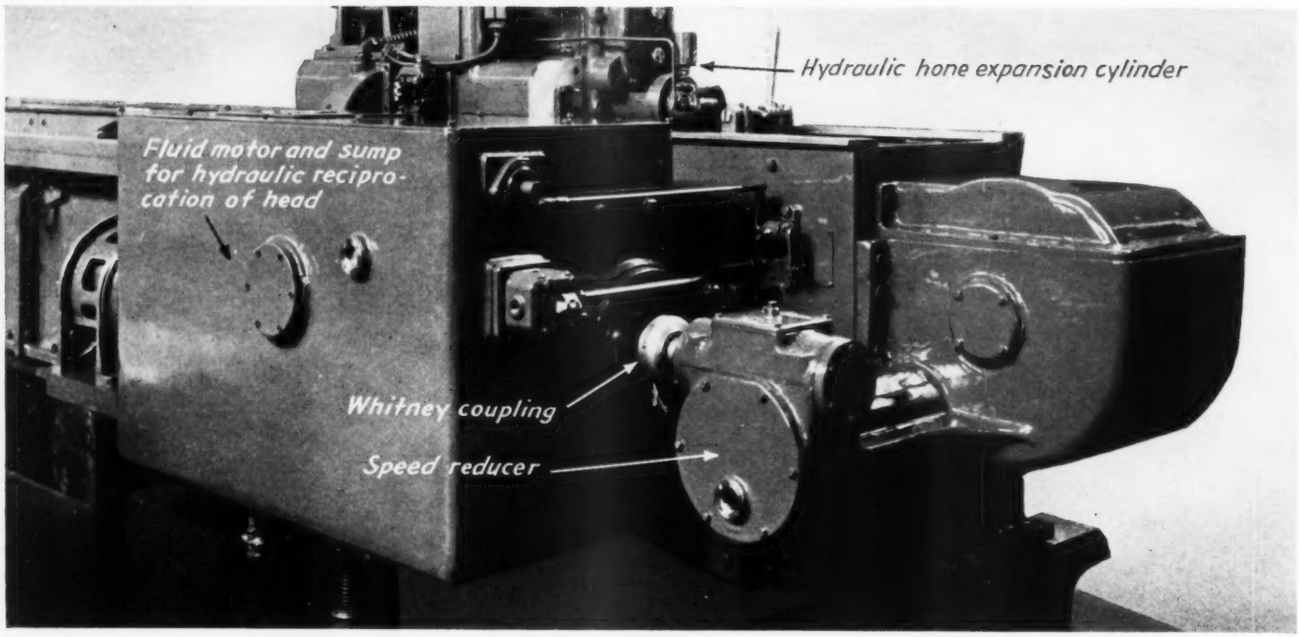
Pushbutton controls, grouped on one panel near end of work table, start and stop reciprocating motor and coolant pump, and also reverse direction of rotation of spindle motor. The lever next to the pushbutton station controls machine operations. Movement of lever from side to side starts and stops reciprocating motion. Movement in and out closes and opens switch to spindle motor. Relays, contactors and other electrical equipment are housed inside machine frame, protected from grease.

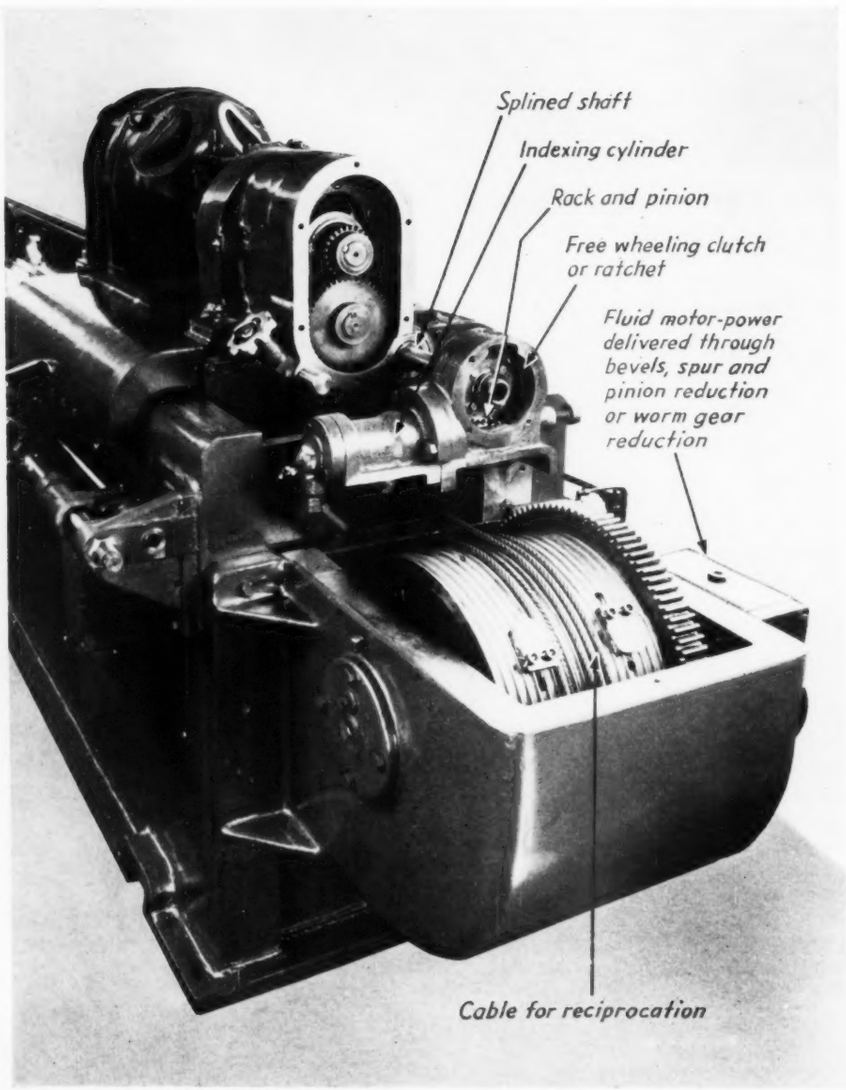
Coolant which drains to that part of base which supports sliding head is returned to sump by a standard automobile-type gasoline pump actuated by an eccentric cam fastened to the idler sheave, as shown below. Rubber tubing carries coolant to honed surface.

(Continued on next page)



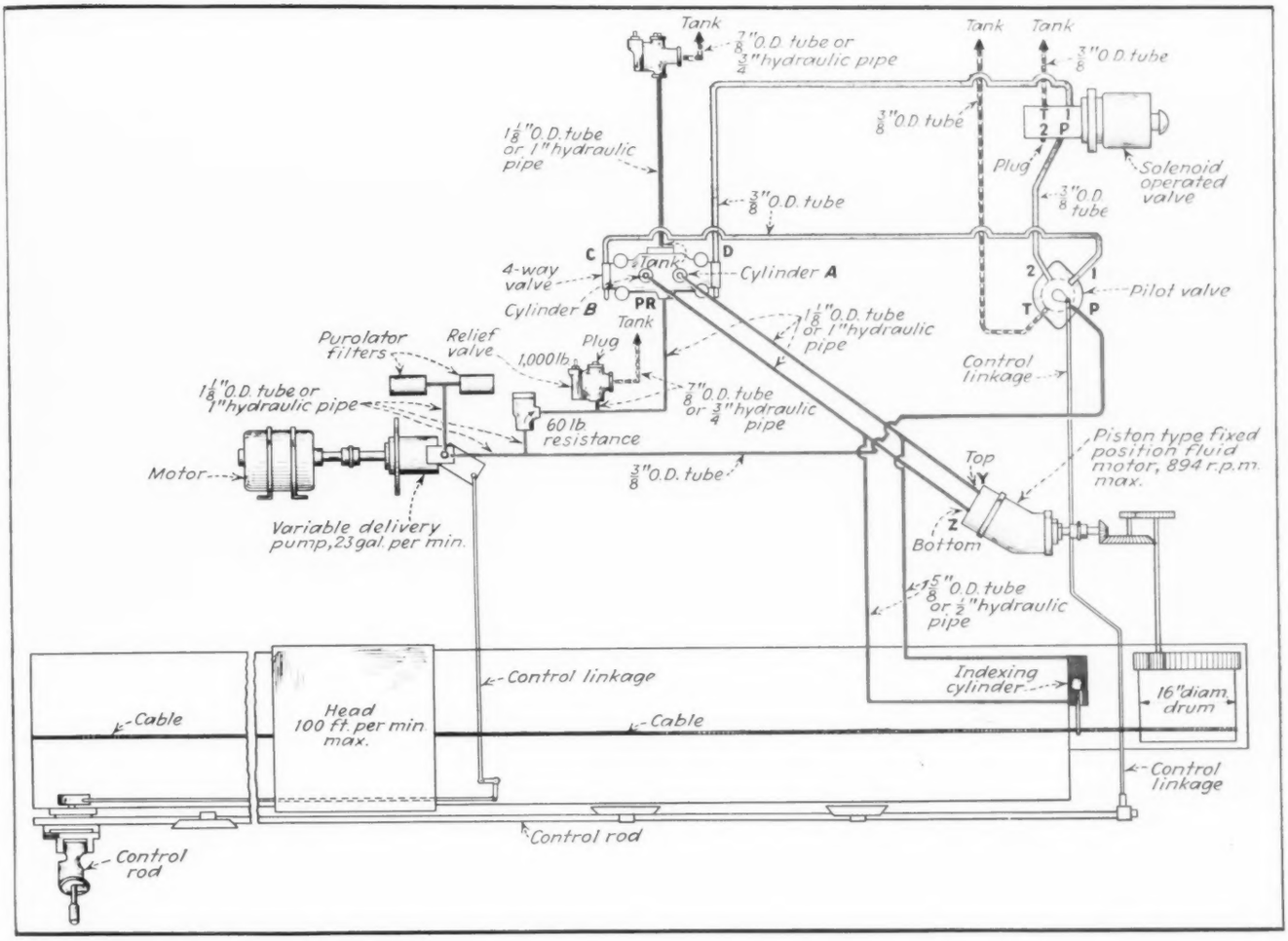


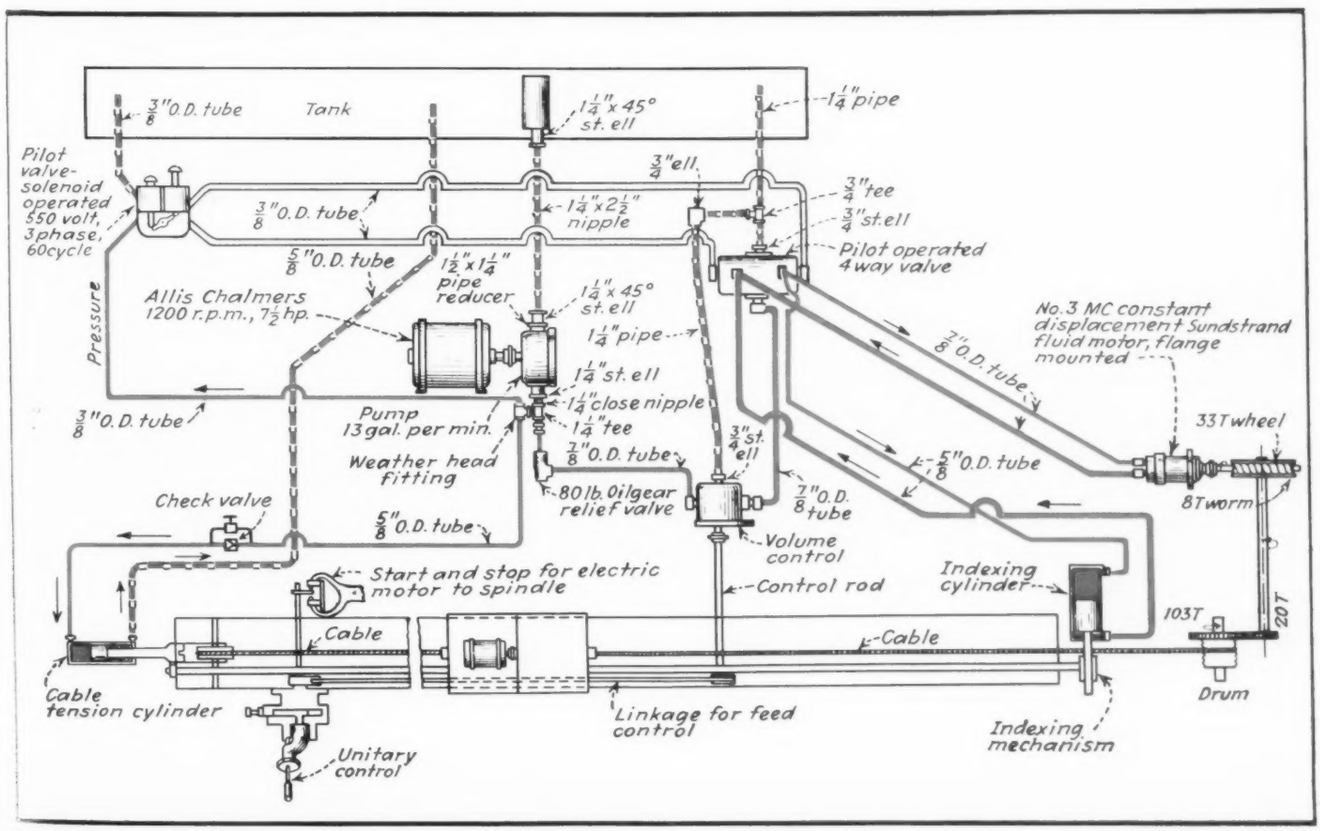

Hydraulic hone expansion cylinder
Fluid motor and sump for hydraulic reciprocation of head
Whitney coupling
Speed reducer


Splined shaft
Indexing cylinder
Rack and pinion
Free wheeling clutch or ratchet
Fluid motor-power delivered through bevels, spur and pinion reduction or worm gear reduction
Cable for reciprocation

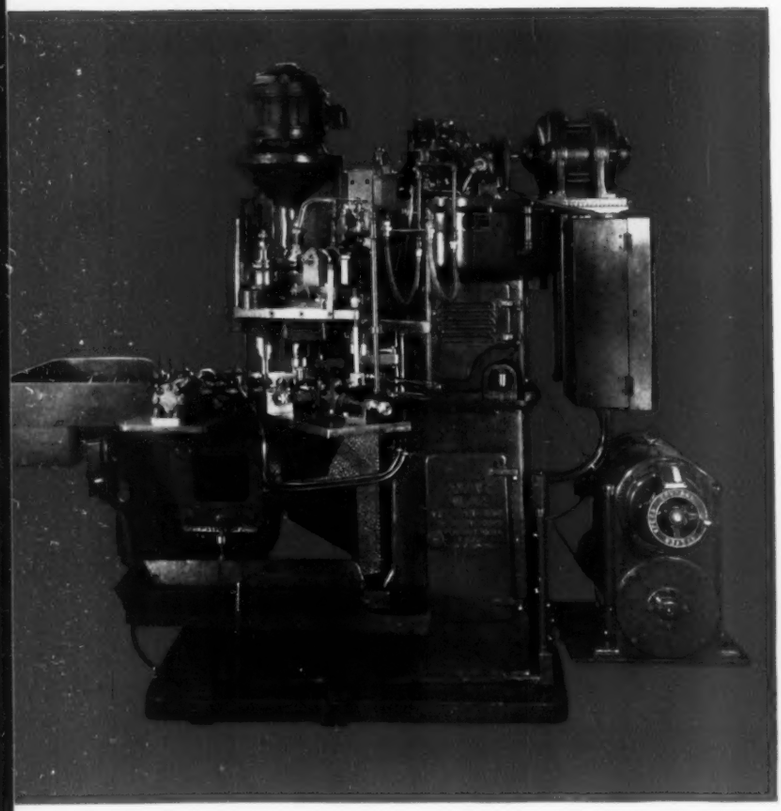
Two typical hydraulic systems used on BarnesdriL horizontals are shown on the facing page. The lower circuit is used on hydraulic honing machines where a straight line lapping attachment indexes the hone slightly after each stroke and holds it during reciprocation. A constant delivery pump with volume control varies the rate of hone travel; a solenoid pilot valve reverses direction of movement. Hydraulic cylinder in reciprocating-motion circuit indexes spindle and hone. Upper drawing shows the circuit in which a variable delivery pump provides varying working rates. A mechanical pilot valve is actuated through a linkage, rotating control rod and cams. A Tuthill constant delivery pump is used in hone expansion circuit. Lubricant is furnished to gears in head from relief valve outlet in this circuit.

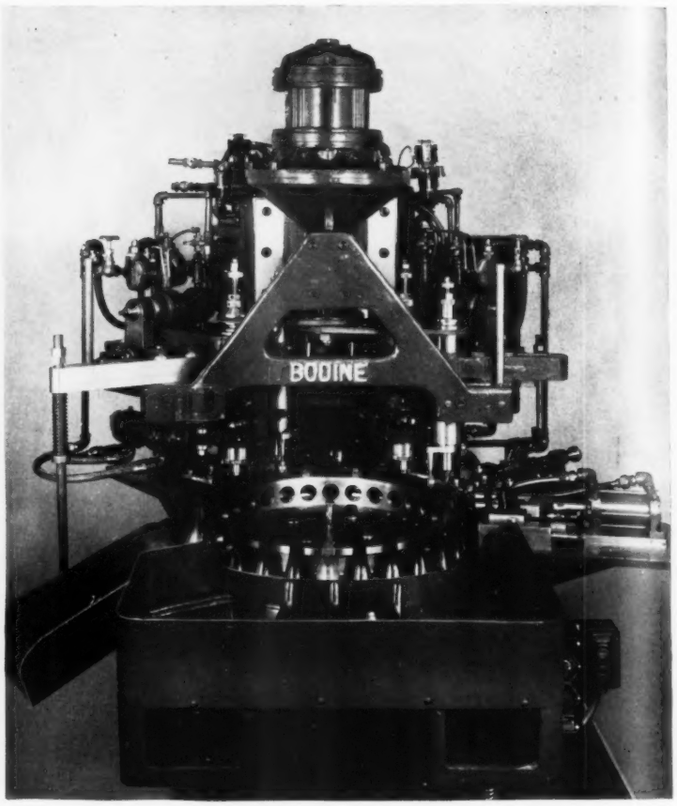
Head is reciprocated by a fluid motor which, through suitable gearing, drives a large grooved drum around which is wrapped a steel cable. One end of the cable is fastened to the rear of head while other end travels forward to an idler sheave, over it and back to front of head. A hydraulic cylinder connected in the circuit keeps cable taut. Pressure is applied to the reciprocating circuit and to the cylinder simultaneously, moving sheave fore or aft as required, maintaining cable tension.


Tank
7/8"O.D. tube or 3/4"hydraulic pipe
Tank
Tank
3/8"O.D. tube
1 1/8"O.D. tube or 1"hydraulic pipe
3/8"O.D. tube
Plug
Solenoid operated valve
3/8"O.D. tube
3/8"O.D. tube
C
D
4-way valve
Tank
Cylinder A
Cylinder B
PR
Pilot valve
Tank
Purolator filters
Relief valve
Plug
1,000lb.
1 1/8"O.D. tube or 1"hydraulic pipe
Control linkage
1 1/8"O.D. tube or 1"hydraulic pipe
7/8"O.D. tube or 3/4"hydraulic pipe
60 lb. resistance
Motor
3/8"O.D. tube
Top
Piston type fixed position fluid motor, 894 r.p.m. max.
Variable delivery pump, 23 gal. per min.
Bottom
1 5/8"O.D. tube or 1/2"hydraulic pipe
Control linkage
Indexing cylinder
16"diam. drum
Cable
Head 100 ft. per min max.
Cable
Control linkage
Control rod
Control rod


3/8"O.D. tube
Tank
1 1/4"x 45° st. ell
1 1/4"pipe
Pilot valve-solenoid operated 550 volt, 3phase, 60cycle
3/4"ell
3/4"tee
3/8"O.D. tube
1 1/4"x 2 1/2" nipple
3/4"st.ell
5/8"O.D. tube
1 1/2"x 1 1/4" pipe reducer
Pilot operated 4 way valve
Allis Chalmers 1200 r.p.m., 7 1/2 hp.
1 1/4"x 45° st. ell
No. 3 MC constant displacement Sundstrand fluid motor, flange mounted
Pressure
1 1/4"pipe
7/8"O.D. tube
1 1/4"st. ell
1 1/4"close nipple
33T wheel
3/8"O.D. tube
Pump 13 gal. per min.
1 1/4"tee
3/4"st. ell
Weather head fitting
7/8"O.D. tube
5/8"O.D. tube
80 lb. Oilgear relief valve
7/8"O.D. tube
8T worm
Check valve
5/8"O.D. tube
Volume control
Start and stop for electric motor to spindle
Control rod
Indexing cylinder
103T
20T
Cable
Cable
Drum
Cable tension cylinder
Linkage for feed control
Indexing mechanism
Unitary control

Bodine Dial Type Automatic Machine

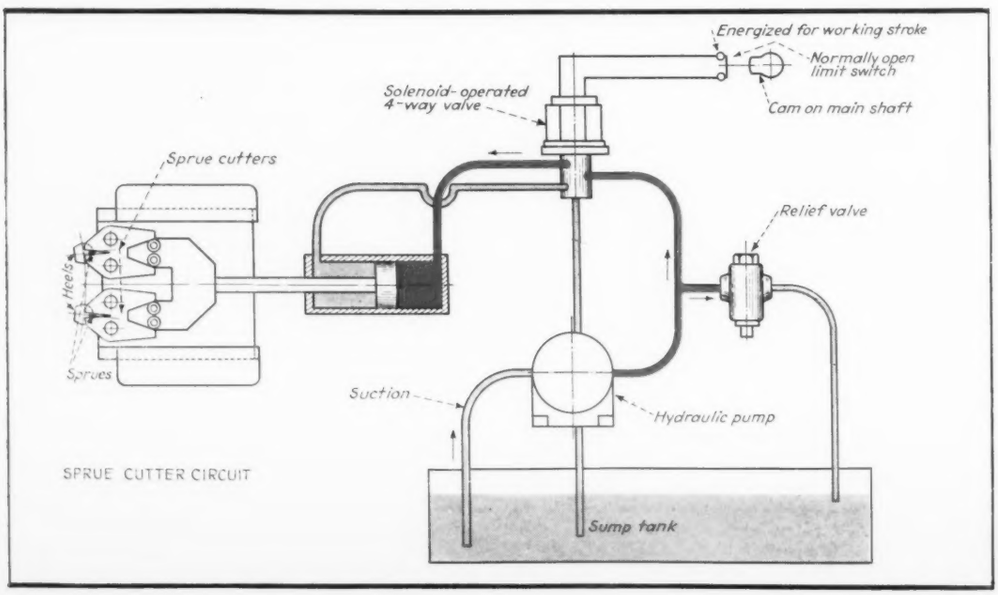


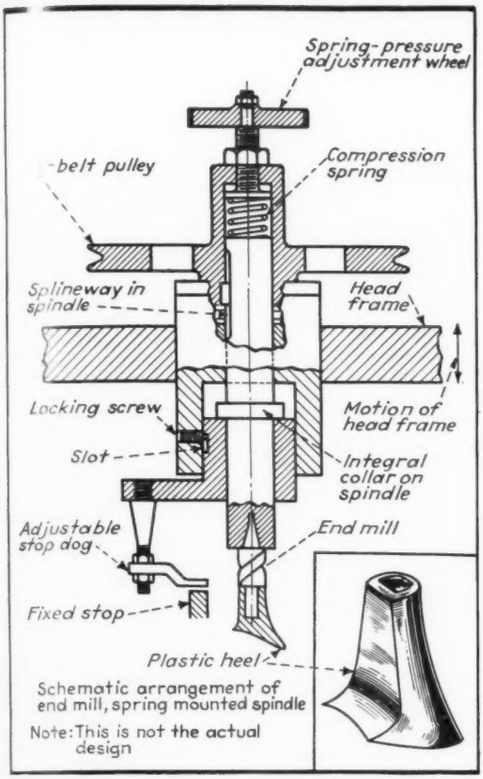


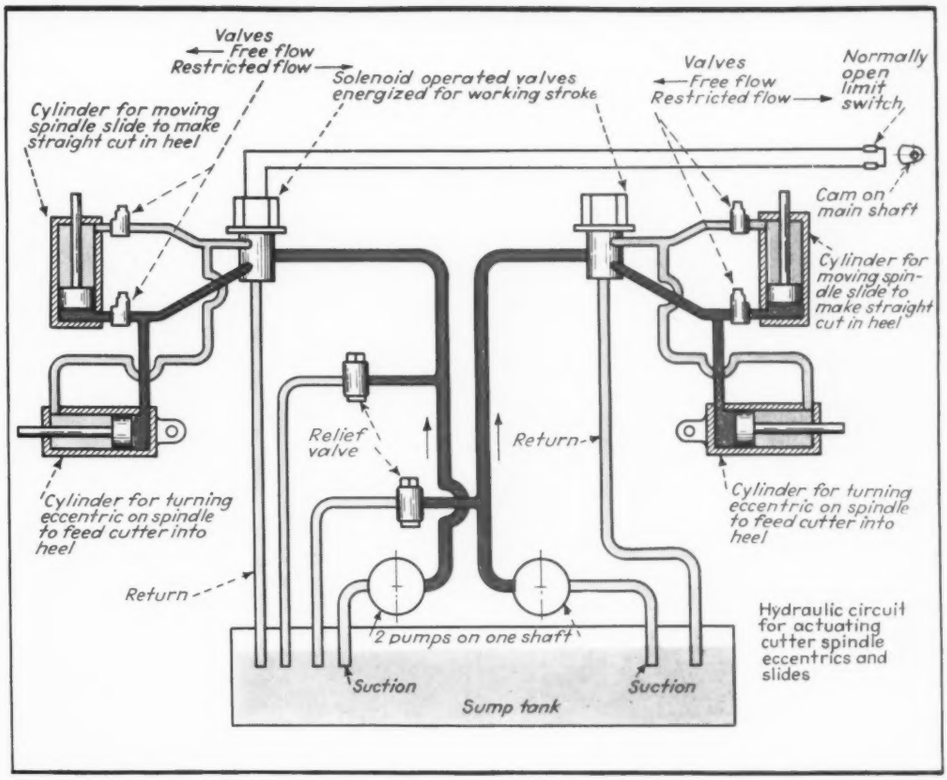
A special adaptation of one of its standard units, the Bodine Corporation's dial type automatic machine for finishing molded cellulose acetate shoe heels is shown here with guards removed so as to reveal more of its construction. In successive indexings the long sprue on the bottom of the heel is sheared off, the short remaining sprue is milled down exactly flush with the surface of the bottom of the heel and finally an undercut is put in a slot in the heel, the purpose of the undercut being to provide a detent for a spring clip used to fasten the leather lift. On next indexing the heels are ejected automatically.

Sprue cutting operation is shown below. Mounted on a horizontal bracket is a hydraulic cylinder operating two shears which travel on a radial line toward the center of the dial and shear off the sprues approximately $\frac{1}{8}$ in. above surface of heel. Separate motor driven hydraulic pump mounted at upper rear of machine furnishes the oil. Cylinder operation is timed by a cam on the main camshaft contacting a switch to cause operation of a solenoid control valve.

Production is two pieces per stroke, twenty strokes per minute, or 2,000 heels per 50-minute hour. Any one of ten sizes of heel can be machined without changing dial equipment or set-up because locating points remain constant. All spindles are mounted on a vertical slide. All spindles are rotated by an independent motor mounted on the slide of the machine with a continuous flat synthetic-rubber impregnated belt passing over all spindle pulleys. All other motions are cam or hydraulically operated with solenoid valve control and automatic hydraulic sequence.

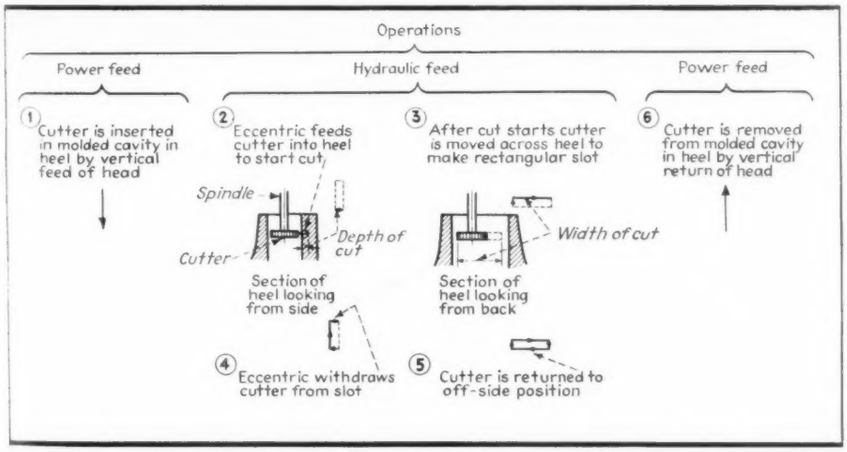




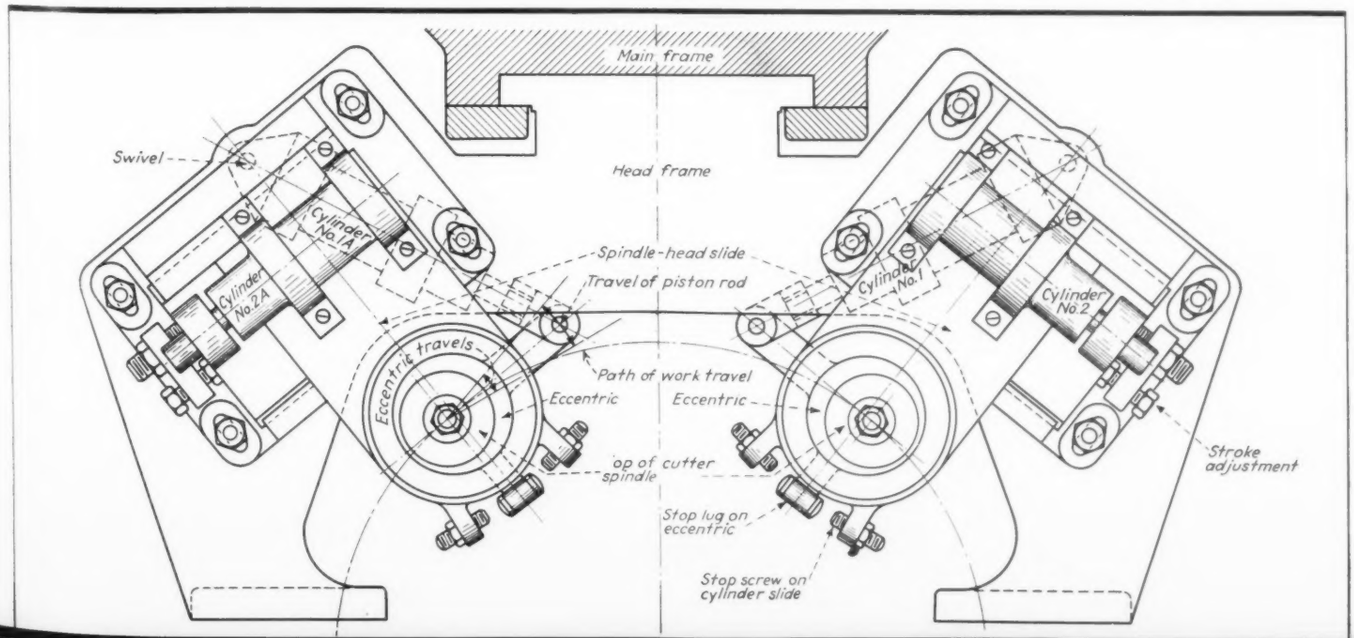

Valves
Free flow
Restricted flow
Solenoid operated valves energized for working stroke
Valves
Free flow
Restricted flow
Normally open limit switch
Cylinder for moving spindle slide to make straight cut in heel
Cam on main shaft
Cylinder for moving spindle slide to make straight cut in heel
Relief valve
Return
Cylinder for turning eccentric on spindle to feed cutter into heel
Cylinder for turning eccentric on spindle to feed cutter into heel
Return
2 pumps on one shaft
Suction
Suction
Sump tank
Hydraulic circuit for actuating cutter spindle eccentrics and slides

End-milling cutters machine the sprues flush. To control downward feed of end-mill a combination of pressure feed and spring mounting of spindle allows feeding milling cutter always exactly flush with the heel regardless of sprue height.

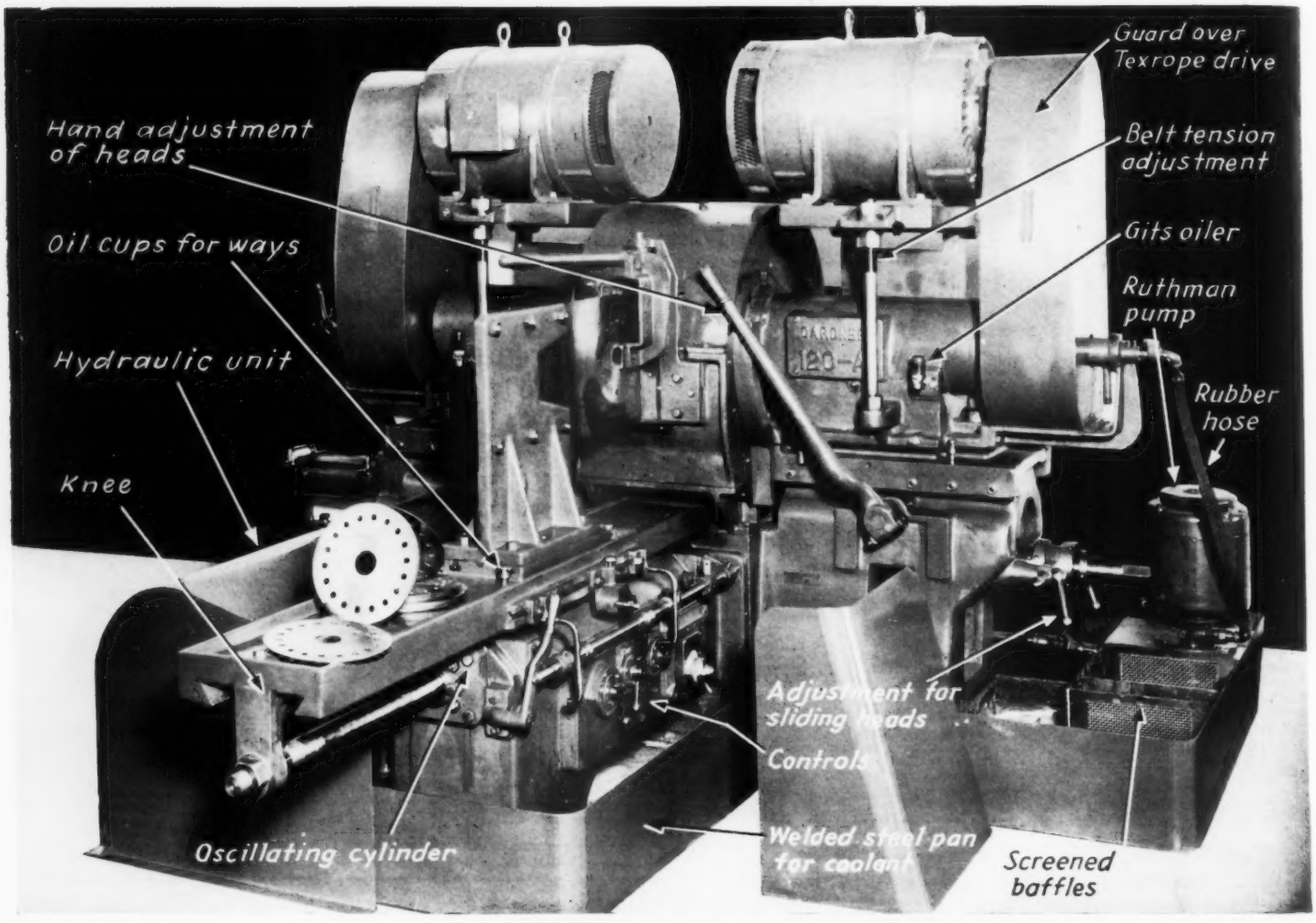
To mill undercut it was required to drop a small cutter into the slot, move it inward $\frac{1}{16}$ in., then straight across $\frac{11}{32}$ in., then outward again $\frac{1}{16}$ in. and finally, with the slide in its upward position and while the dial was indexing, return the cutter to its original starting position. This motion was accomplished by using a hydraulic cylinder on slide to operate an eccentrically mounted spindle on which the amount of throw was adjustable between the two limiting stop screws.


Operations
Power feed
Hydraulic feed
Power feed
1 Cutter is inserted in molded cavity in heel by vertical feed of head
2 Eccentric feeds cutter into heel to start cut
3 After cut starts cutter is moved across heel to make rectangular slot
6 Cutter is removed from molded cavity in heel by vertical return of head
Spindle
Depth of cut
Cutter
Width of cut
Section of heel looking from side
Section of heel looking from back
4 Eccentric withdraws cutter from slot
5 Cutter is returned to off-side position

Schematic diagram showing the operation in producing the undercut. One cylinder for each spindle controls the eccentric throw, a second controls lengthwise movement of entire spindle assembly. As the dial indexes, the slide comes down and an electric switch operated from a cam on the main camshaft opens an electric solenoid operated valve to the cylinder operating the eccentric throw. When stop is contacted, pressure builds up and hydraulic oil passes through pressure valve to second hydraulic cylinder which moves entire spindle assembly in a line perpendicular to the direction of the first motion. On completion of this travel pressure reverses and cycle repeats.

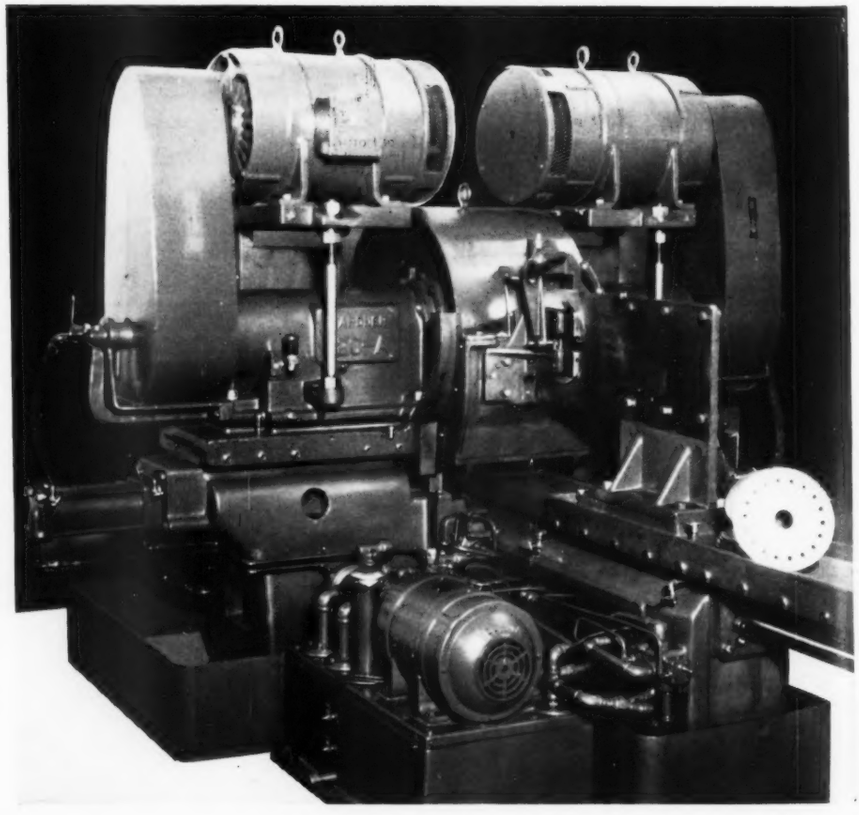


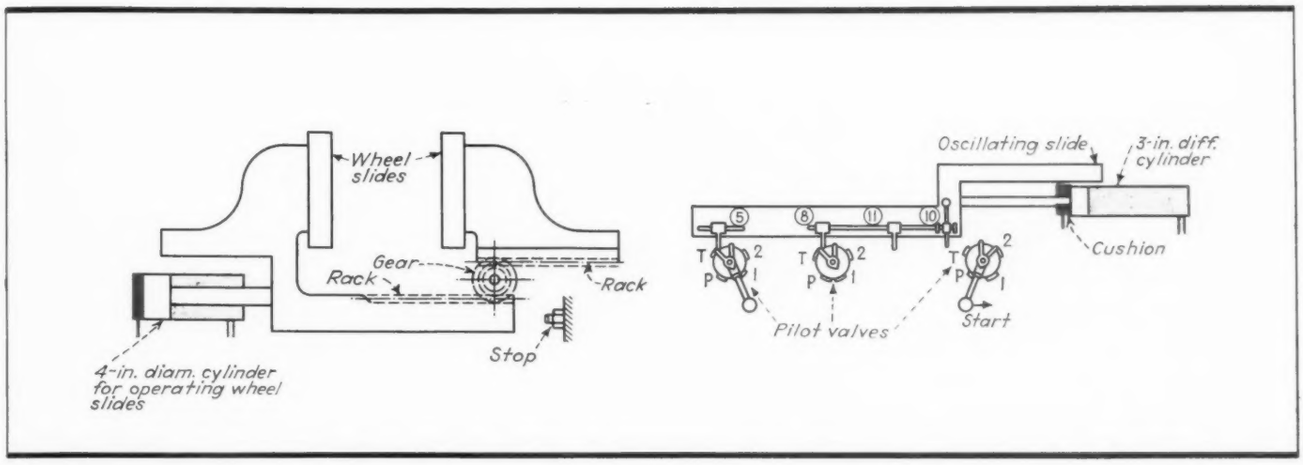
Grinding Heads and Table Are Moved Hydraulically



Drive and Transmission. Standard electric motors drive the grinding wheel spindles through Tex-rope drives, each spindle being driven independently, in the Gardner Precision Disk Grinder. Spindles are mounted in pre-loaded roller bearings at wheel end which take thrust and radial loads. A ball bearing at rear supports radial loads only, with this arrangement the spindle can expand lengthwise without affecting the position of the grinding wheel. Gits oilers are used to keep oil at a constant level on the spindle bearings. Garlock inclosures and labyrinth keep coolant out of spindle housing at wheel end while packings around coolant supply pipe and a centrifugal slinger keep coolant out at drive end.

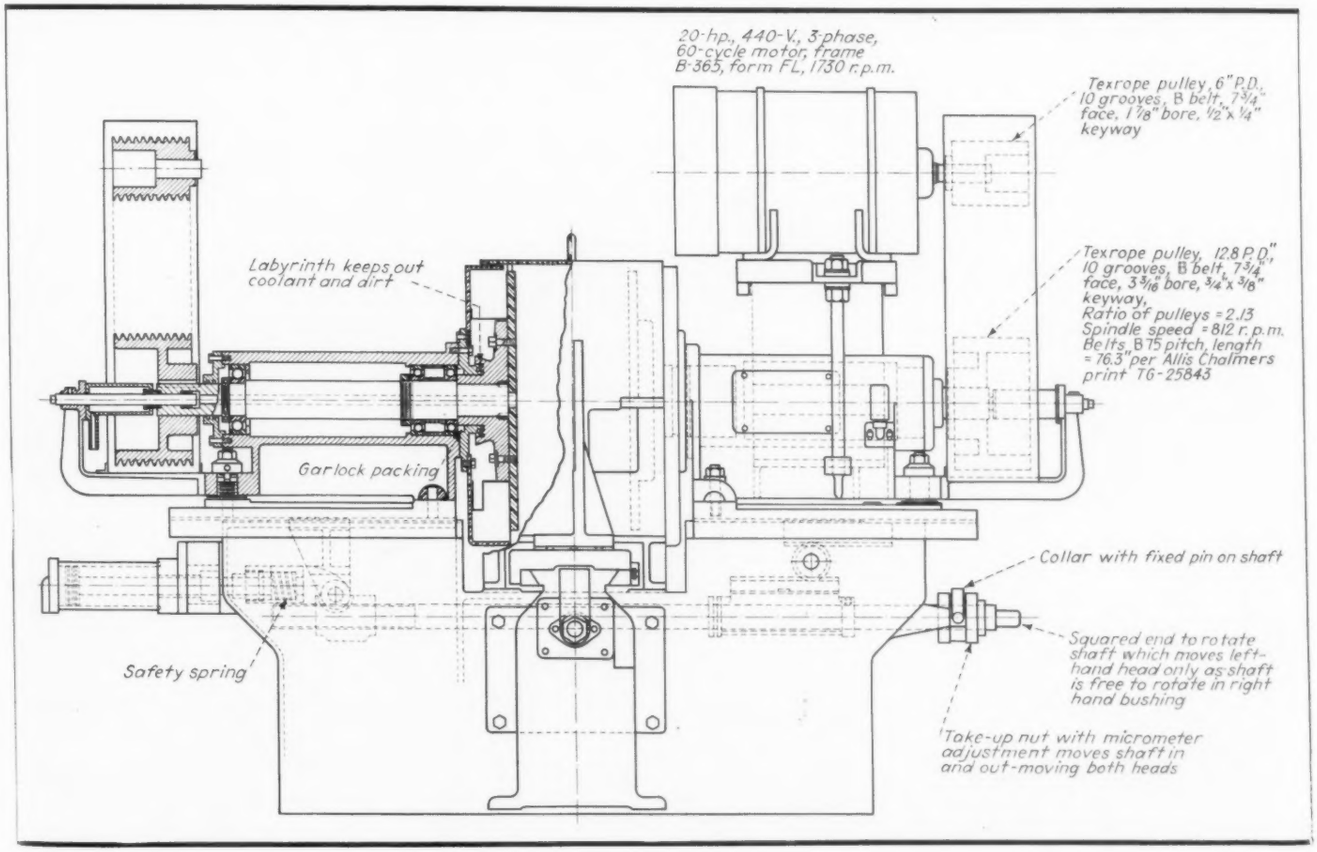
To meet the increased demand for production and accuracy cast frames are made with heavier walls. Cast iron is used for all frames, heads and bed. Where particularly easy movement is desired ball bearing ways are used. The base sets inside a welded sheet steel pan which acts as coolant sump. Three baffles in the sump strain out foreign matter in the coolant before it reaches the pump intake. Steel wool placed between last two baffles aids in removing the fine dust which is carried suspended in the coolant associated with grinding operations





Wheel slides for traversing and feeding grinding heads and the oscillating slide which carries the work are actuated hydraulically. In the hydraulic circuit are two constant volume displacement pumps, one for the wheel slide system and the other for the oscillating slide system. The two systems are interlocked with hydraulic pilot lines to obtain proper timing. Adjustable trip dogs on oscillating slide are used to operate automatically pilot valves in hydraulic circuit.

The oscillating table starts from its extreme left hand position and rapid traverses for approximately 9 in., then automatically slows down to a feed rate, at which time the wheel heads begin their forward movement. The oscillating slide then continues to travel approximately 7 in. at the feed rate and oscillates through this stroke until the work sparks out.


20-hp., 440-V., 3-phase, 60-cycle motor, frame B-365, form FL, 1730 r.p.m.
Texrope pulley, 6" P.D., 10 grooves, B belt, 7 3/4" face, 1 7/8" bore, 1/2" x 1/4" keyway
Texrope pulley, 12.8 P.D." 10 grooves, B belt, 7 3/4" face, 3 5/16" bore, 3/4" x 3/8" keyway, Ratio of pulleys = 2.13 Spindle speed = 812 r.p.m. Belts, B 75 pitch, length = 76.3" per Allis Chalmers print TG-25843
Labyrinth keeps out coolant and dirt
Garlock packing
Collar with fixed pin on shaft
Squared end to rotate shaft which moves left-hand head only as shaft is free to rotate in right hand bushing
Safety spring
Take-up nut with micrometer adjustment moves shaft in and out-moving both heads

Rack and gear arrangement is employed to give the right and the left-hand wheel heads equal and opposite motions, using only one hydraulic cylinder. The length of the shaft rod, which connects the left-hand and the lower right-hand rack with the hydraulic piston end, can be varied by rotating the shaft which is threaded into a nut under the left-hand rack. The right-hand rack is bushed to fit the shaft and is held in position by two collars. The shaft is free to rotate in the bushing in the right-hand rack. Changing the length of the shaft increases or decreases the distance between the faces of the grinding wheels when in position to begin their strokes. A micrometer dial is provided on the take-up arrangement so that adjustments in wheel spacing can be made with precision.

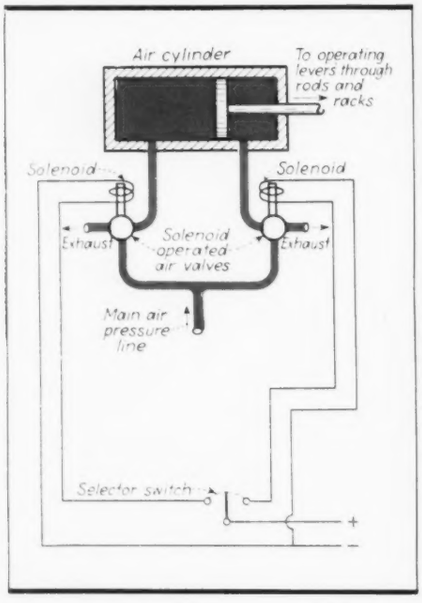
Each grind wheel is driven by a 20-hp. motor which drives the spindle through a Tex-rope drive. The motors are mounted on the grind wheel carriages.

Electro-Pneumatic Control on Horizontal Machine

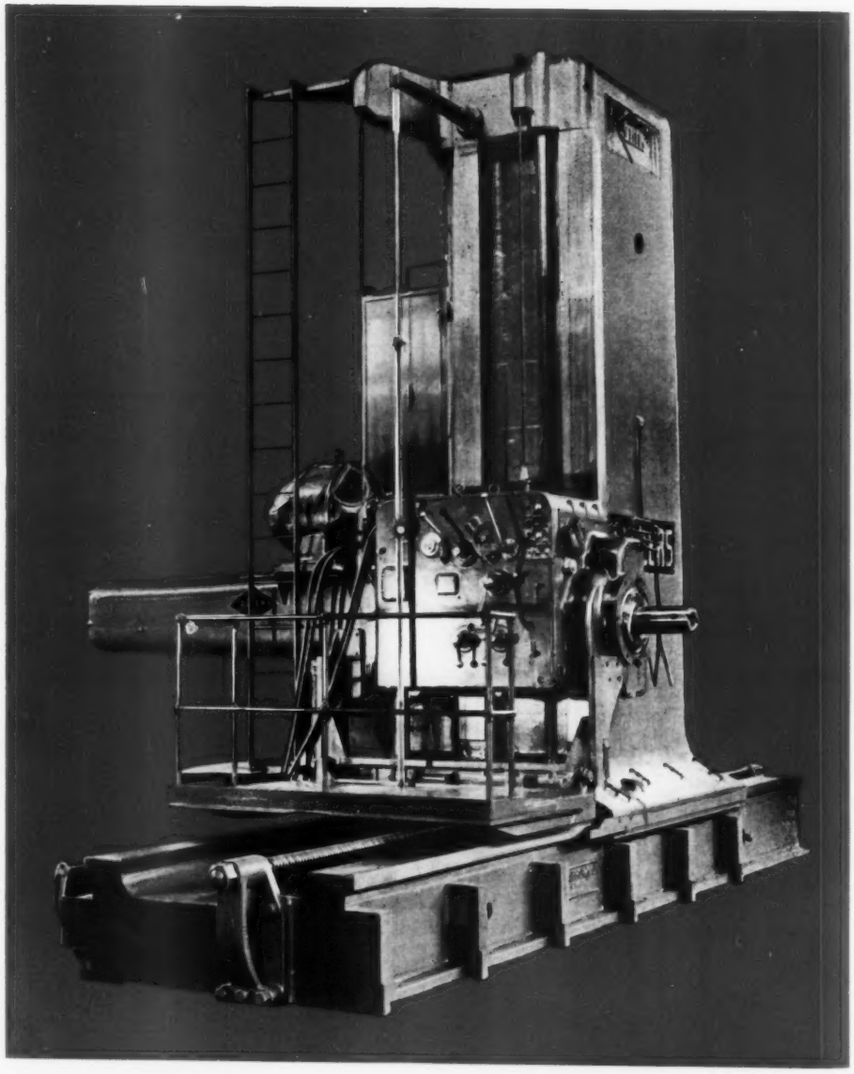
ENTIRE drive assembly, all speed and feed change gearing and hand and power traverse to spindle, head and column are grouped in the unit head on the Sellers 7-in. spindle horizontal boring, drilling and milling machine. Short, multiple-splined gear shafts, of heat-treated alloy steel, are supported in anti-friction bearings. No long shafts or bevel gears are used. Gears are heat-treated alloy steel. Feed and power traverse engage through multiple-disk clutches.

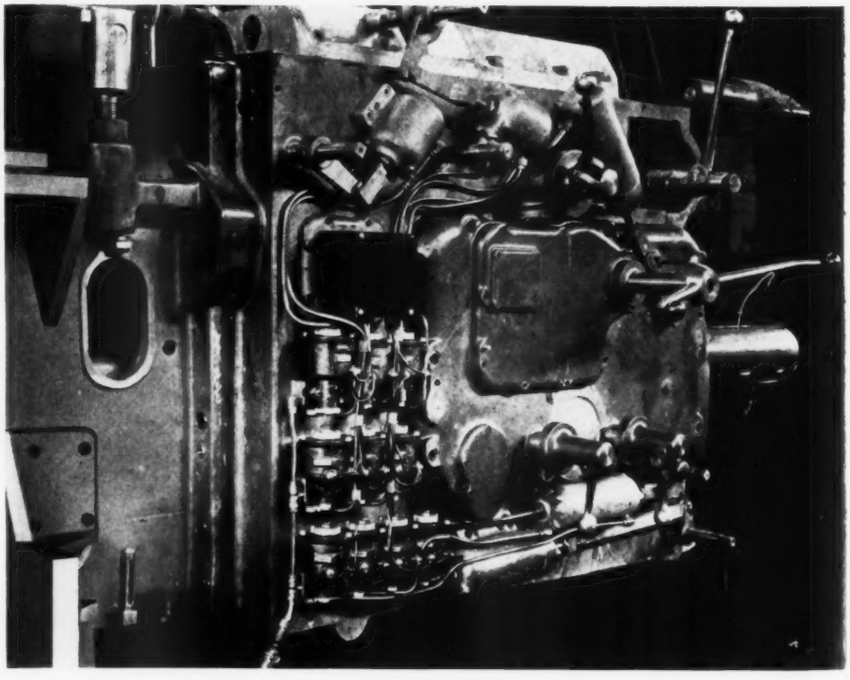
Spindle is of Nitralloy steel, 750 Brinell. Spindle sleeve is a chrome-moly, heat-treated steel forging, carried on three pre-loaded, Timken zero-precision bearings. A spring-loaded, rawhide seal at the front end of the spindle wipes spindle as it is drawn into the sleeve. Two filler keys, flush with spindle and ground to spindle radius, prevent chip entrance through keyways.

Column, cast of alloy iron, is a heavy, rectangular box section, square locked to bed with steel gibs. It is guided on the front way and is fitted with tapered gibs for wear take-up. Column ways are automatically oiled from head and are fitted with bronze scrapers and felt seals. Bed ways and column traversing mechanism are pressure lubricated. Underside of bed is machined for floor plate.

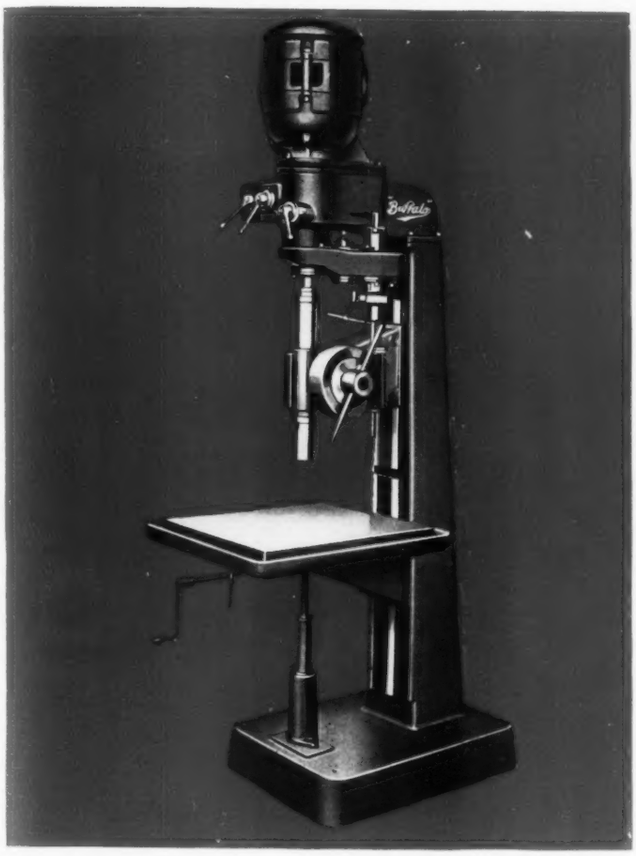


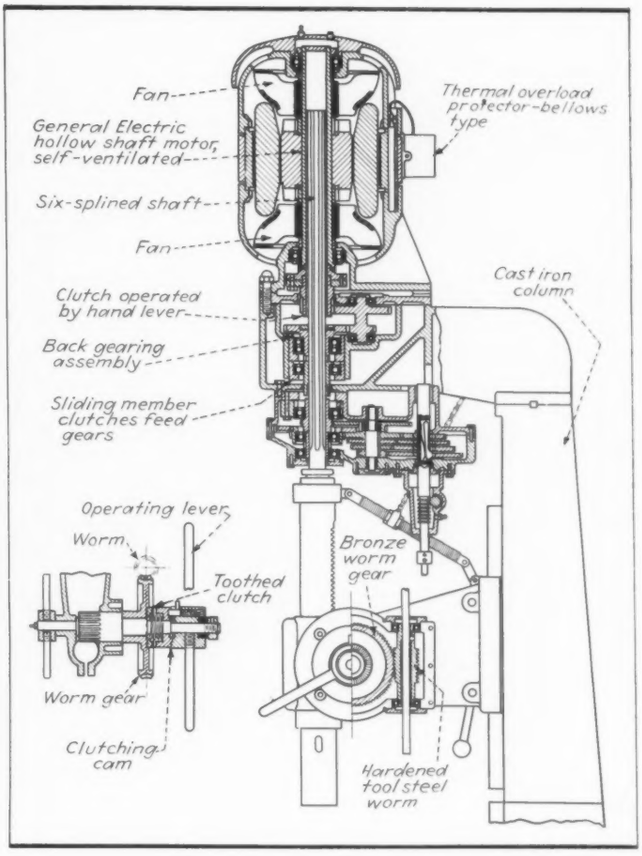
Pneumatic cylinders controlled by solenoid-operated valves actuate clutches through rods and racks. Solenoid valves are located in the unit head and are operated on a secondary circuit by push-buttons and selector switches, grouped in a control panel that may be detached from the head and used as a portable pendant switch. Gear shifting for speed and feed changes is done manually with levers grouped on unit head.





Hollow-Shaft Motor Drives Pedestal Drill

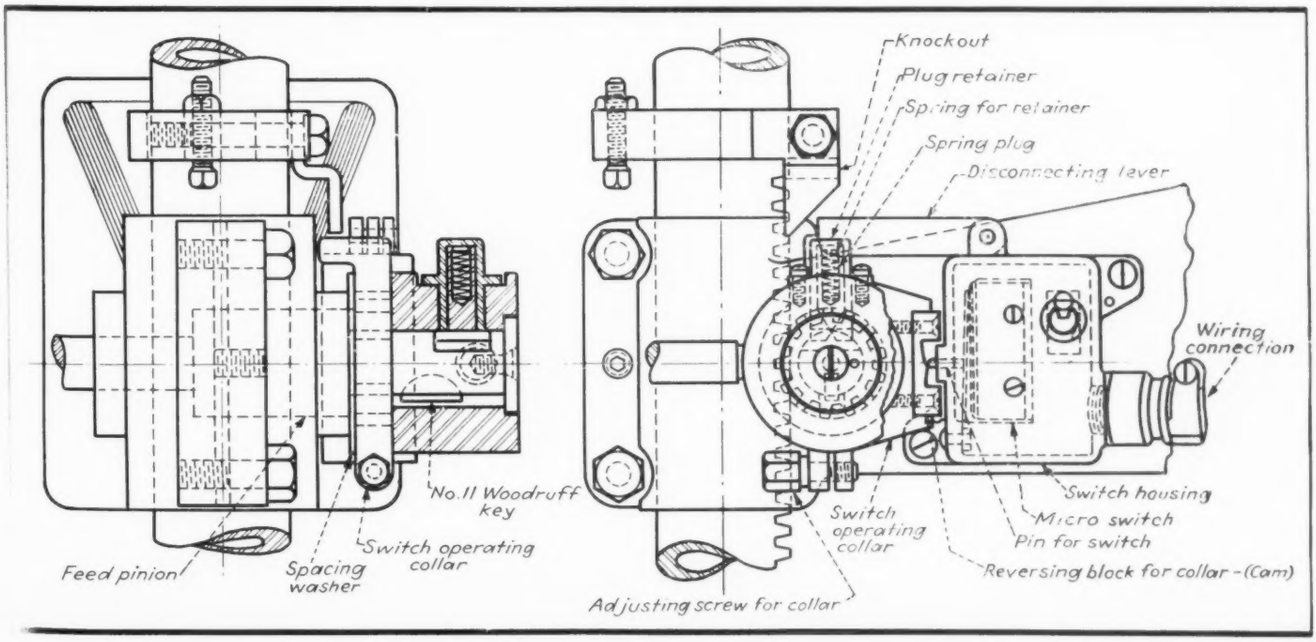




Alloy steels are used for spindles and gearing in the new line of drills designed by the Buffalo Forge Company. Six-splined spindle is fitted in sleeve supported on precision ball bearings. Thrust is taken by collars mounted above sleeve. High speed reduction gears are of helical type. Gear shift handle is interlocked with motor switch for safety.

Motor reverse tapping control unit, shown below, contains a Burgess micro-switch actuated by a hardened cam segment attached to a collar mounted on feed pinion shaft. An adjustable dog on main shaft contacts collar, opening micro-switch. This throws the magnetic switch which reverses motor and withdraws tap from the work.

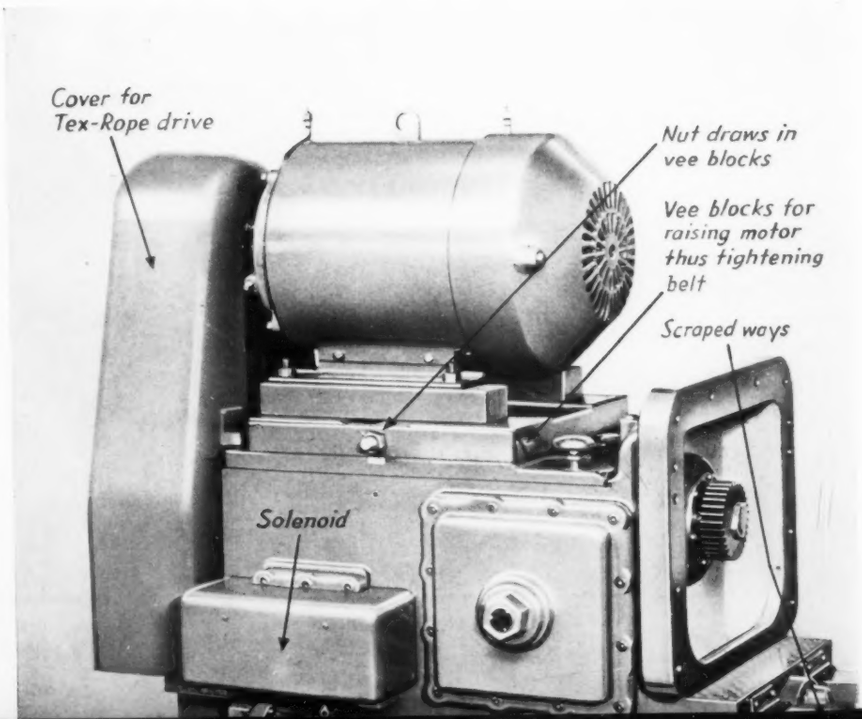
Two specially-designed fans ventilate the General Electric hollow shaft motor, which is mounted on New Departure grease-sealed ball bearings. Overload protection is provided by a bellows-type thermal device; undervoltage protection by a magnetic contactor mounted between line connection and drum-type pole-changing motor switch.

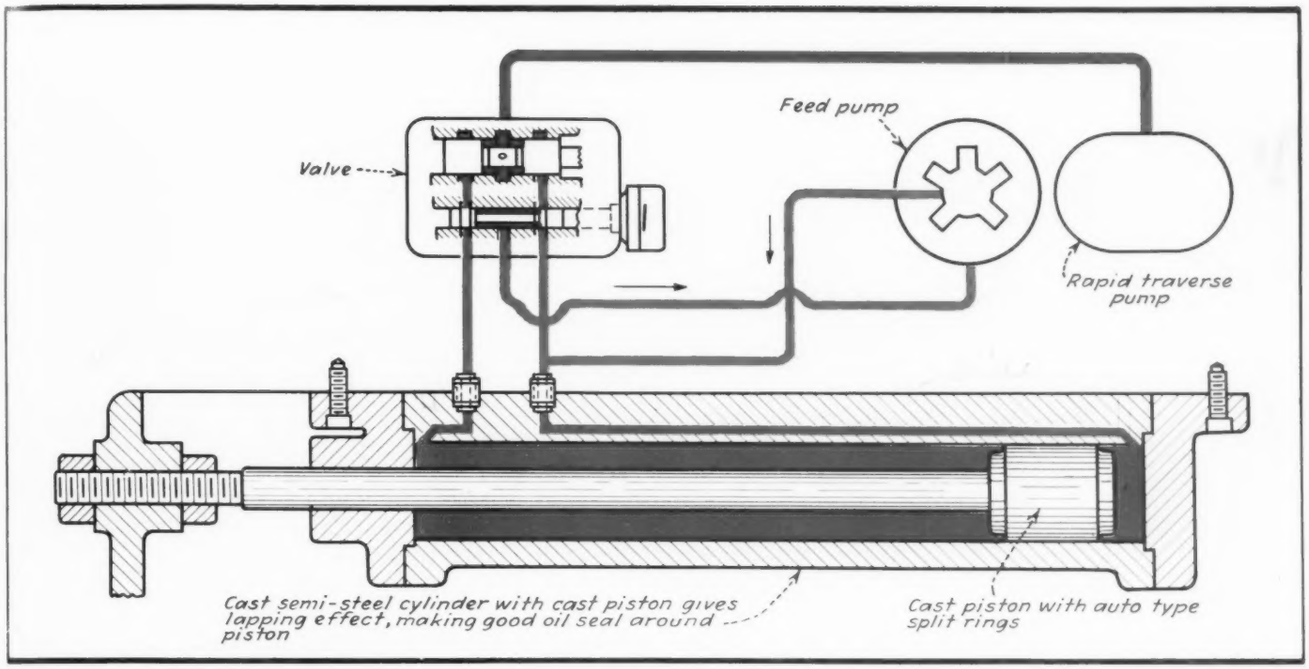


Self-Contained Hydraulic Head Unit

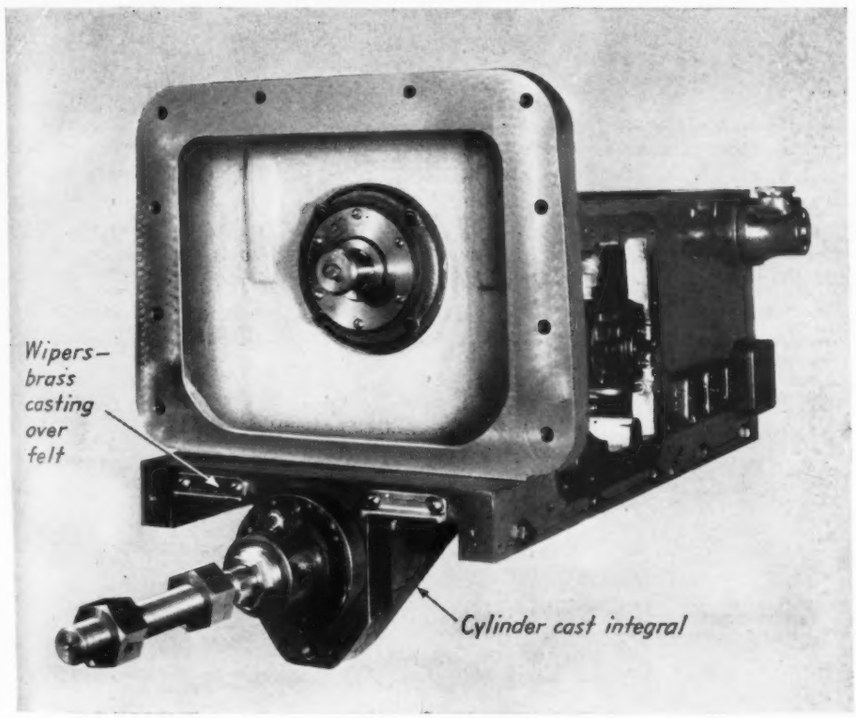
Sliding head unit can be mounted vertically, horizontally or at any angle. Made in various sizes and arranged for mounting on existing machine beds or for use in combination with other units, the W. F. & John Barnes unit uses standard motors having speeds of 1,200–1,800 r.p.m. to suit spindle speed requirements.

Auxiliary base is semi-steel casting, 36 to 40 per cent steel rail being used in the melt along with nickel and chromium, resulting in a dense, close-grained structure. This alloy is such that ways can be scraped almost smooth without the dull graphitic appearance of cast iron. The actuating cylinder, formerly a separate steel part, is now integral with the head casting. No leakage caused by porosity has been reported. Castings are normalized after the first rough machining operation. Head casting also provides a sump for hydraulic unit.


Cover for Tex-Rope drive
Nut draws in vee blocks
Vee blocks for raising motor thus tightening belt
Scraped ways
Solenoid

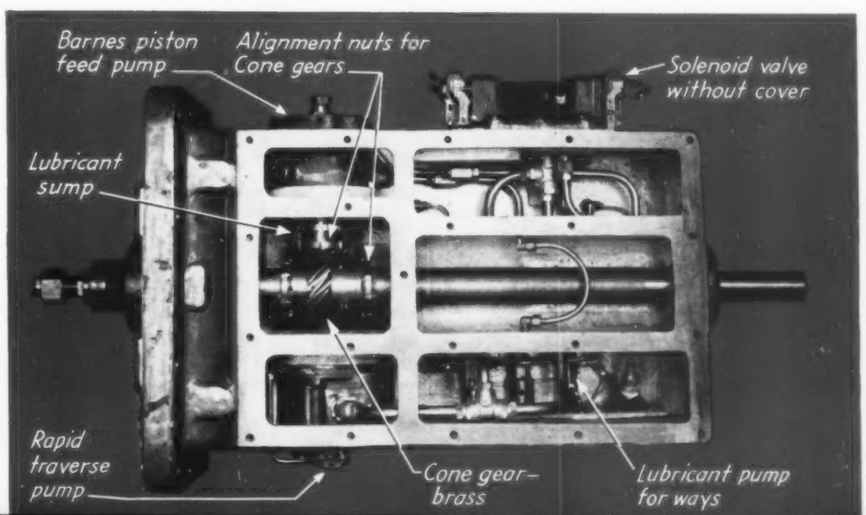

Feed pump
Valve
Rapid traverse pump
Cast semi-steel cylinder with cast piston gives lapping effect, making good oil seal around piston
Cast piston with auto type split rings

Schematic arrangement of Barnes hydraulic control valves and pumps as used in the unit. Valves and connections are manifolded in a single casting. Remaining piping is seamless steel with Parker steel fittings.

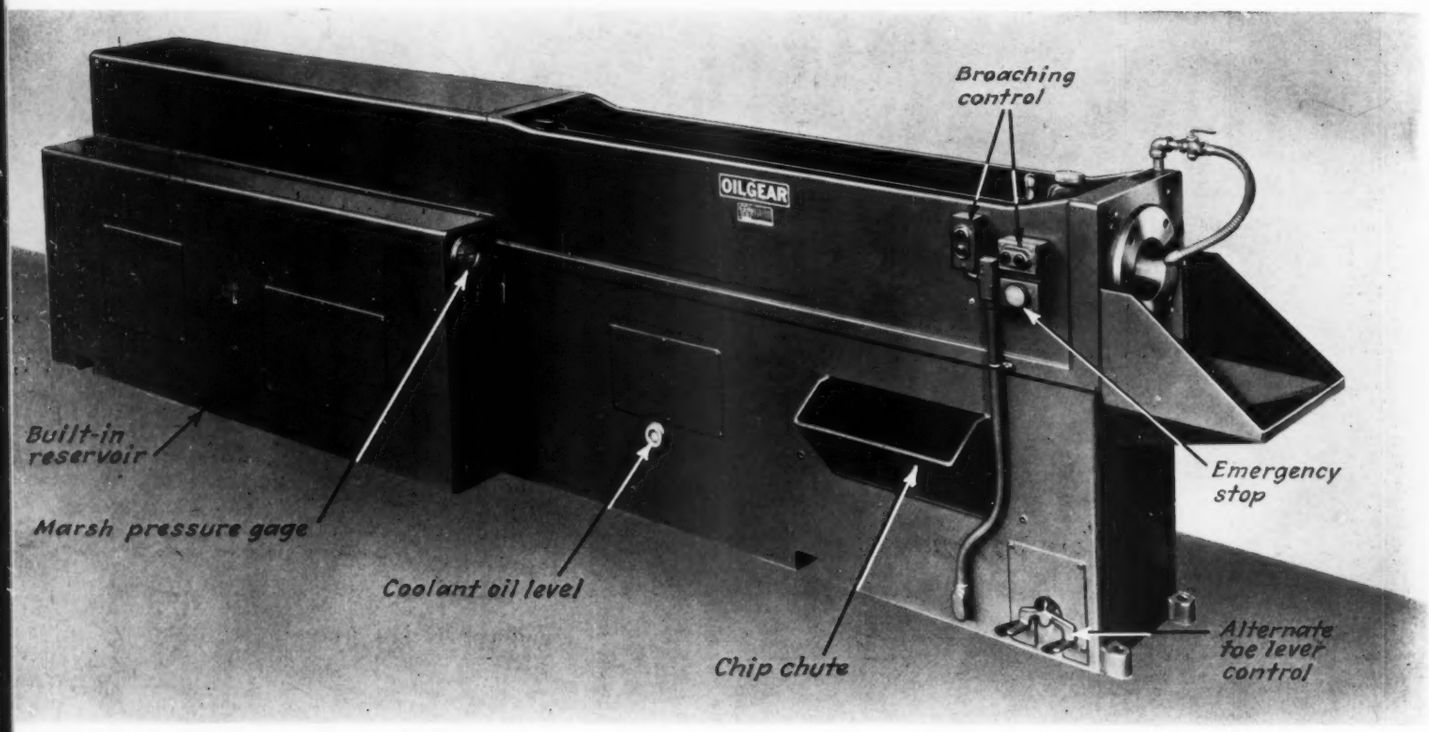


In smaller unit, 3 hp. maximum, a Barnes combination feed and traverse pump is driven by one vee-belt from motor shaft; the remaining three belts drive the spindle. In units larger than 3 hp. five vee-belts drive the spindle. Transverse shaft, on which is mounted a Barnes gear pump (rapid traverse) and a Barnes piston pump (feed), is driven through Michigan Cone gears. These are used instead of a standard worm and gear drive because speed ratio of the two shafts is low, approaching 1:1. Gear shafts are threaded and fitted with lock nuts to permit exact alignment of the Cone gears after assembly. Ways on larger units are lubricated with oil from hydraulic circuit; on smaller units a large oil cup supplies local lubrication.

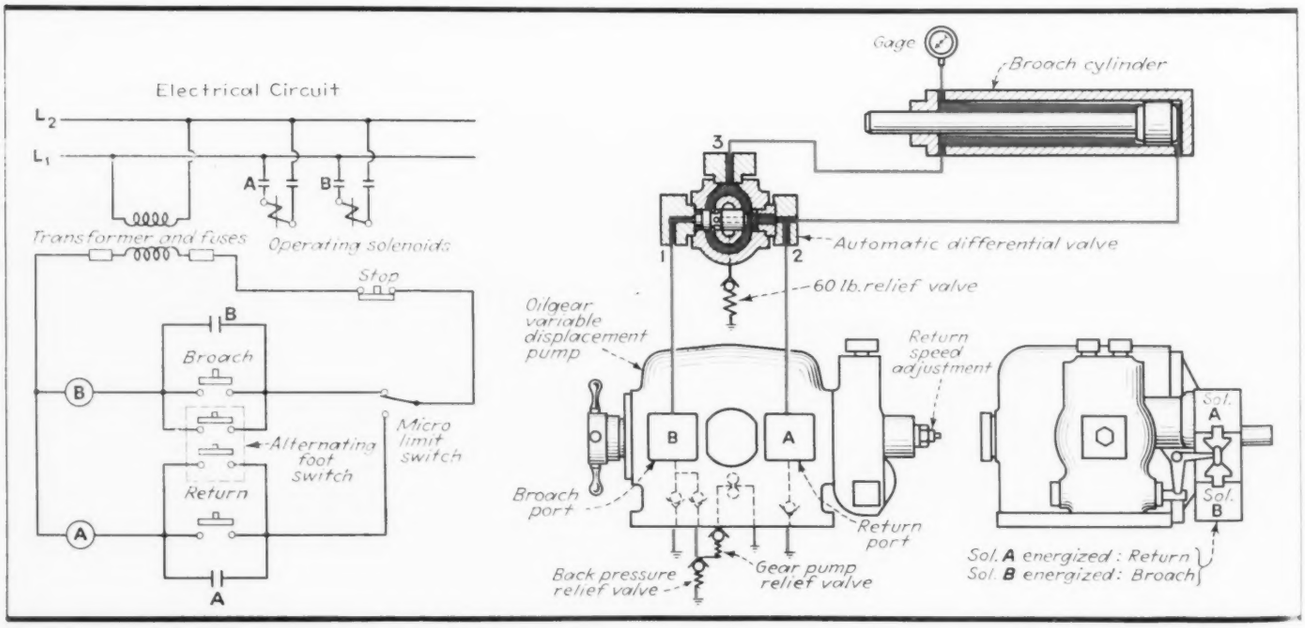
Spindle is mounted on preloaded dual ball-bearings at front end, supported against "whip" by ball-bearing in center and is also supported at end by large roller bearing which takes pulley load. Since head acts as hydraulic oil reservoir, oil leakage around spindle must be prevented. Several methods are used: an oil slinger groove is provided when the oil is below the spindle openings. If oil is above openings a Garlock inclosure is used. Where absolute tightness is required such as in vertical mounting of the unit, a Gits rotary seal is used. Cylinder head is packed with Marsh or Garlock chevron packings.



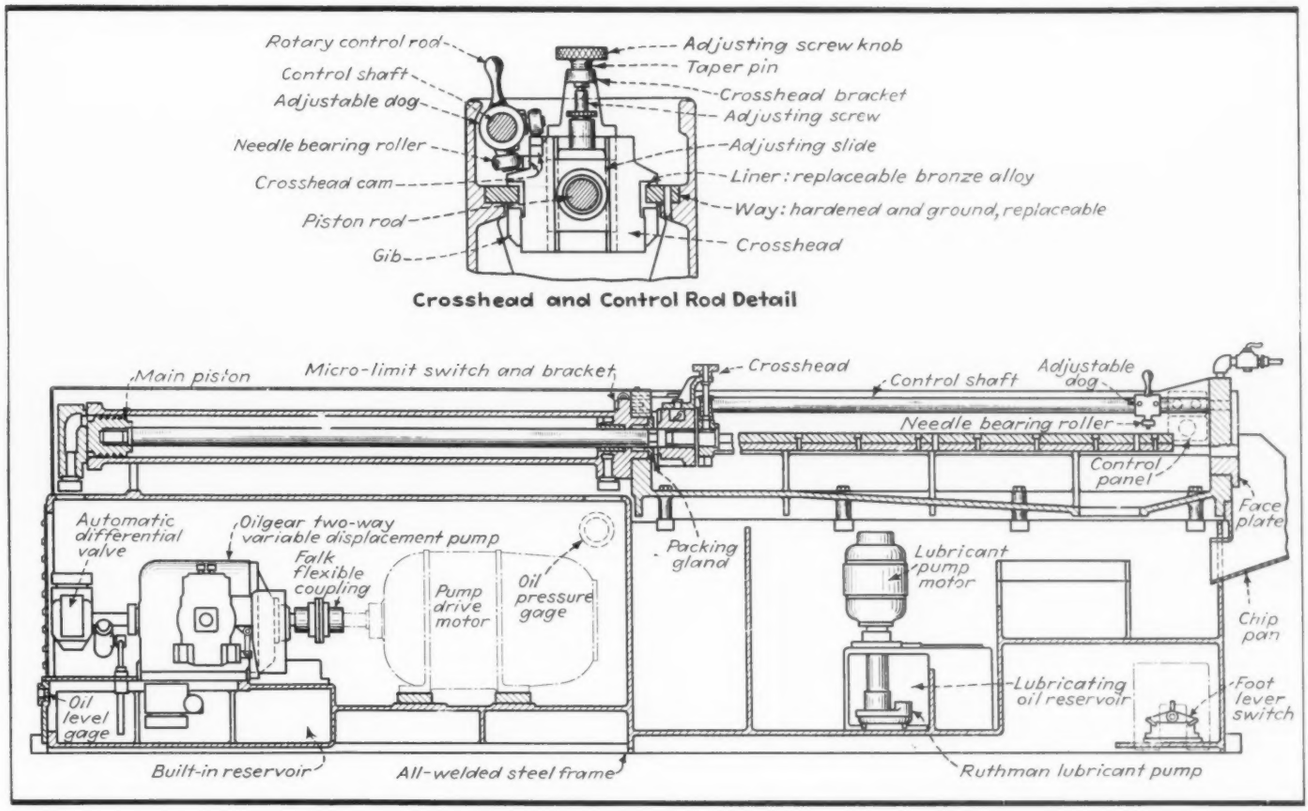
Simplified Stroke Control on Hydraulic Broach



Two-way variable displacement pump in combination with a horizontal cylinder and a differential circuit transmits power to the tool in the Oilgear type XL horizontal broaching machine. Both cutting and return speeds can be adjusted independently. Two adjustable dogs with needle bearing rollers, mounted on the single control rod, contact cams on crosshead to stop tool at any preset stroke and position automatically. Contact of the rollers on the crosshead cams causes rotation of the control rod, closing a limit switch mounted on rod end. This de-energizes a solenoid valve flanged integrally with the pump, cutting off pressure. Simplified control eliminates usual links and levers.

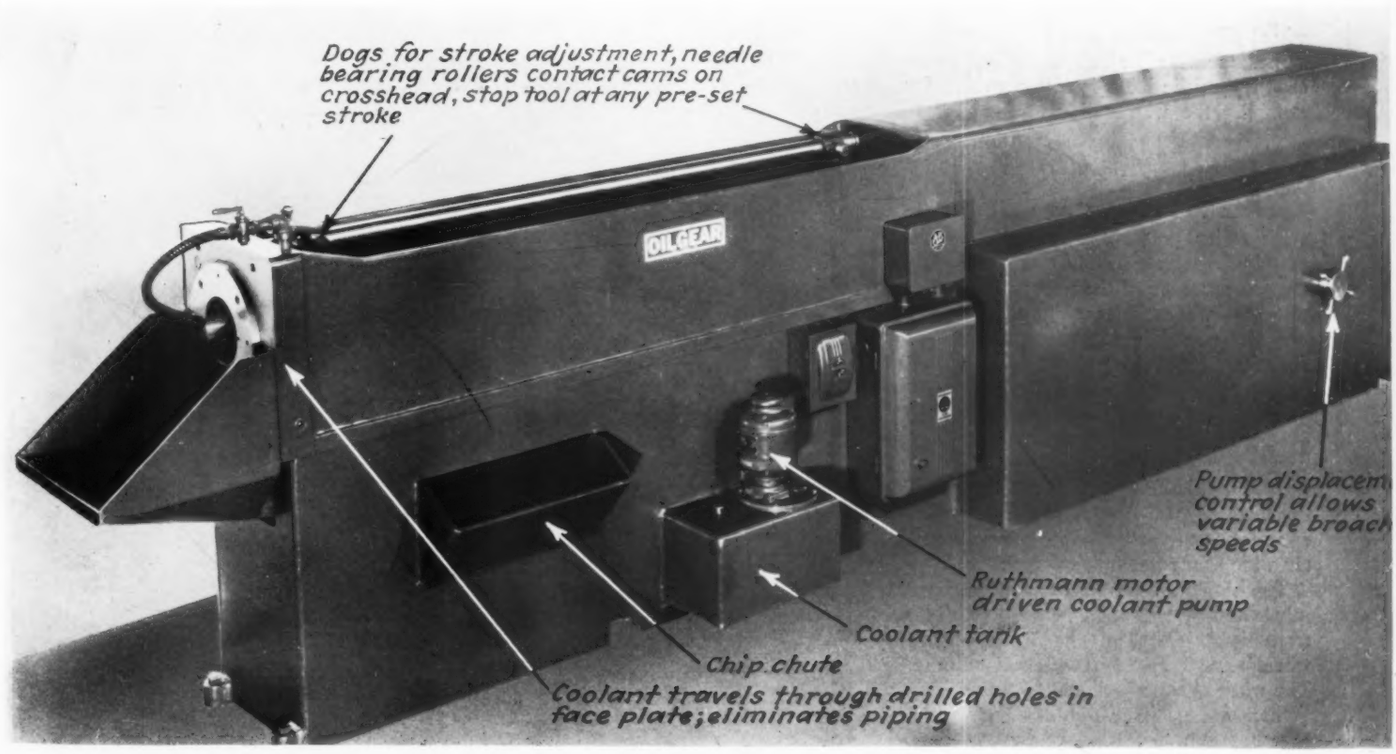


Fluid power from the pump is transmitted to and from the cylinder through an automatic differential valve and two short, seamless steel tubes. Two adjustable relief valves in the Oilgear pump protect machine against overload. Volume and direction of oil flow are controlled at the pump, thus eliminating pilot, volume and control valves and extra piping. Pushbuttons control tool and crosshead motions: one button starts broaching stroke, another starts return stroke. Emergency stop is provided. M tions can also be controlled by a t lever switch. A built-in Marsh pressu gage indicates excessive forces caus by dull tools, excessive stock remov variations in material and overload.

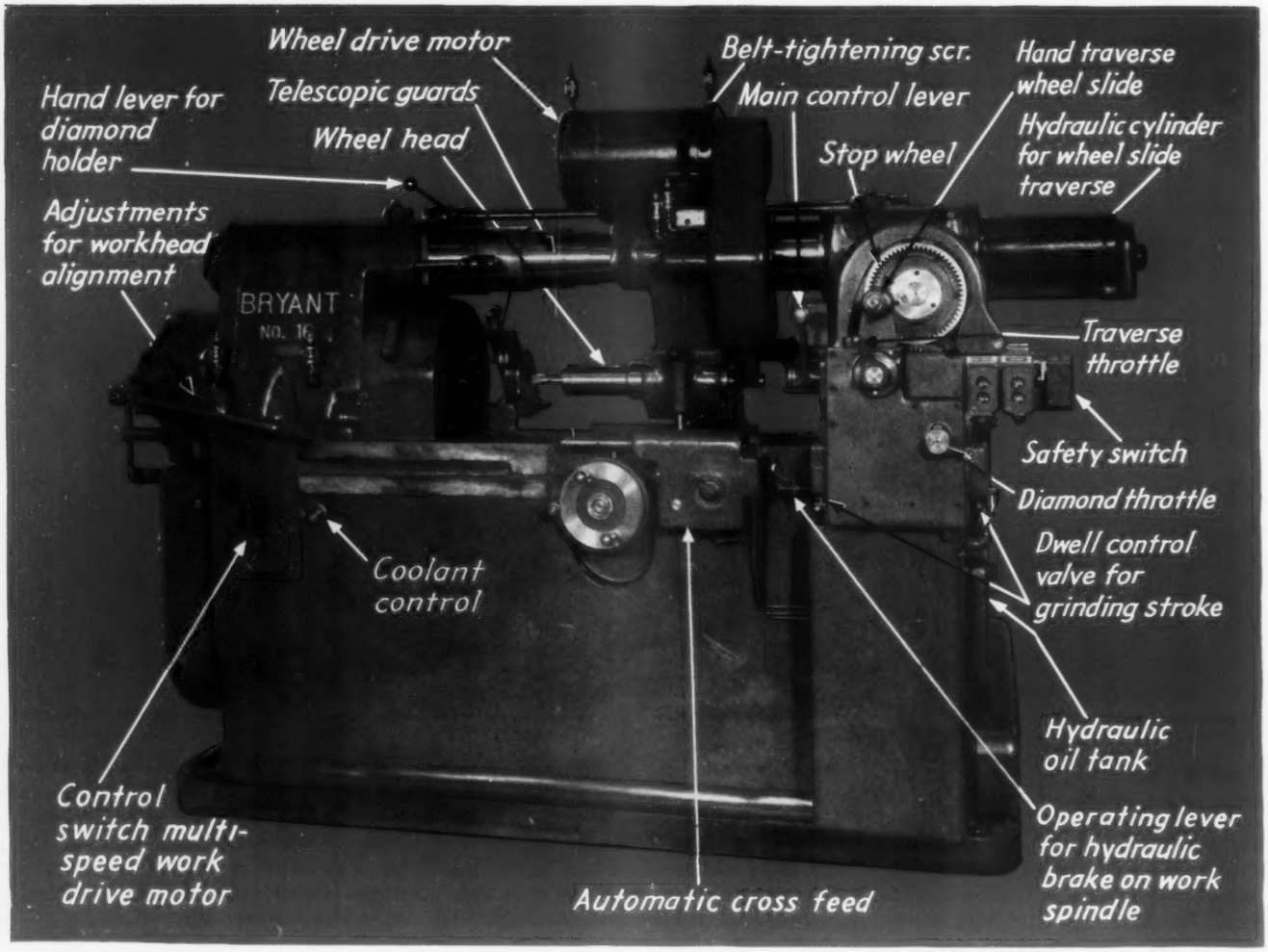


Welded structural steel plates make up the machine frame. Hydraulic equipment, main drive motor and oil reservoir are housed within the base. Broach cylinder is precision bored and honed. Steel crosshead has replaceable bronze liners, and is fitted with a convenient vertical tool adjustment. Replaceable alloy-bronze liners guide the crosshead on hardened and ground, detachable, rectangular ways.

Gravity and capillary feed lubrication is provided to both liners and ways from a reservoir in crosshead. A Ruthman motor driven coolant pump, mounted integral with the base, supplies coolant to tool and work through a flexible hose. Dual chutes permit easy removal of chips from either side of machine; a trough directs chips and excess coolant to settling chamber in base.


Dogs for stroke adjustment, needle bearing rollers contact cams on crosshead, stop tool at any pre-set stroke
OILGEAR
Pump displacement control allows variable broach speeds
Ruthmann motor driven coolant pump
Coolant tank
Chip chute
Coolant travels through drilled holes in face plate; eliminates piping

Hydraulic Lifter Swings Wheel Slide on Grinder

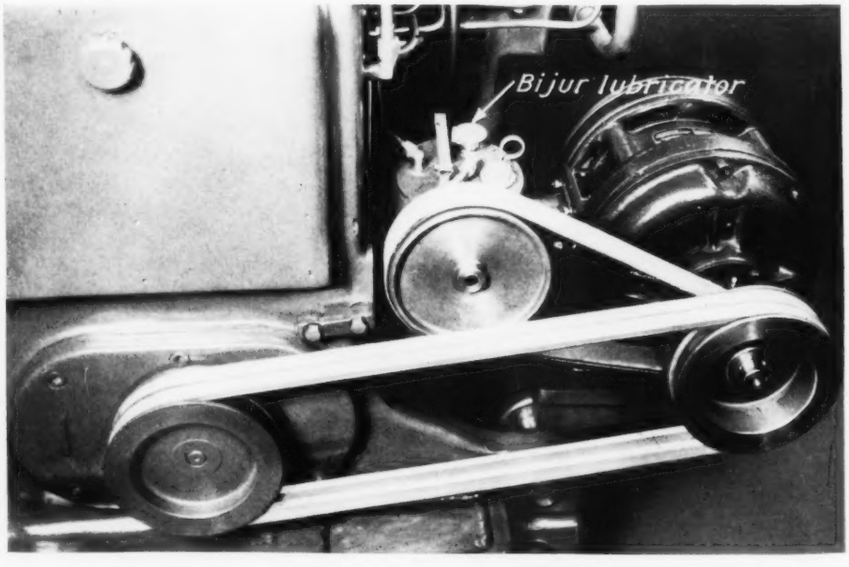


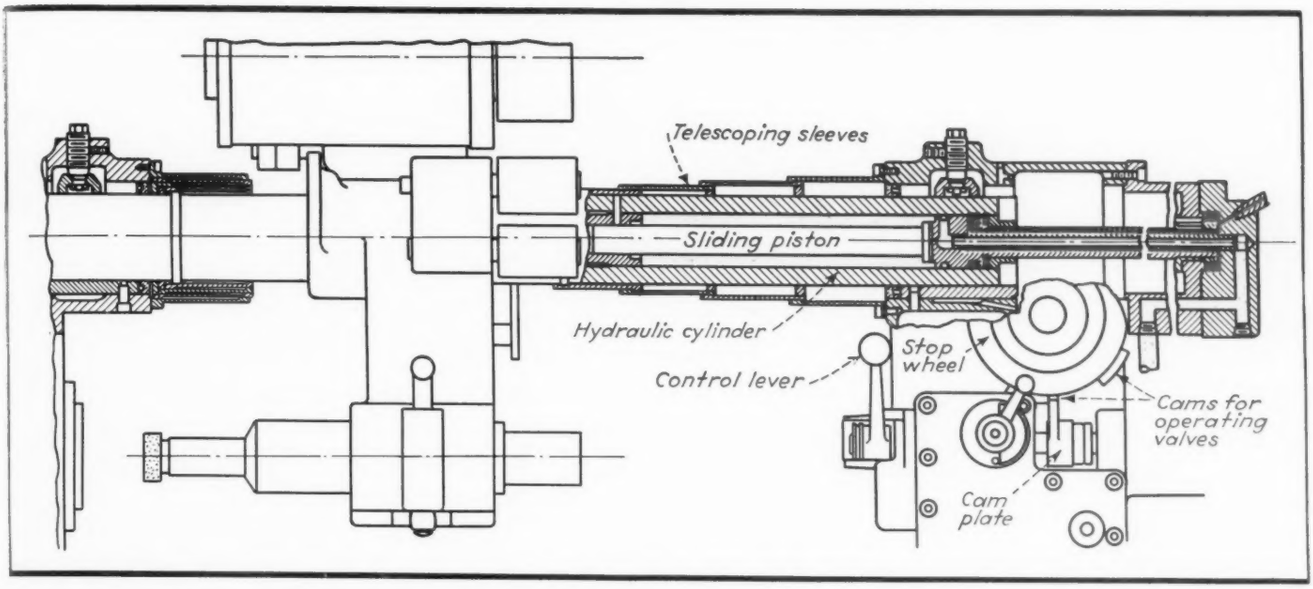
Hydraulic operation of cross feed, wheel slide traverse and brake on work spindle feature Bryant chucking grinders. Hydraulic lifter is also provided for swinging the wheel slide to the rear to give access to the chuck when loading or unloading. The work spindle is driven by V-belts from a multi-speed motor mounted on an adjustable bracket at the back of the machine.

Power cross feed is done with a hydraulic unit placed near the cross-feed screw. Rate of feed of the hydraulic unit can be set for both roughing and finishing cuts and also for no power feed.

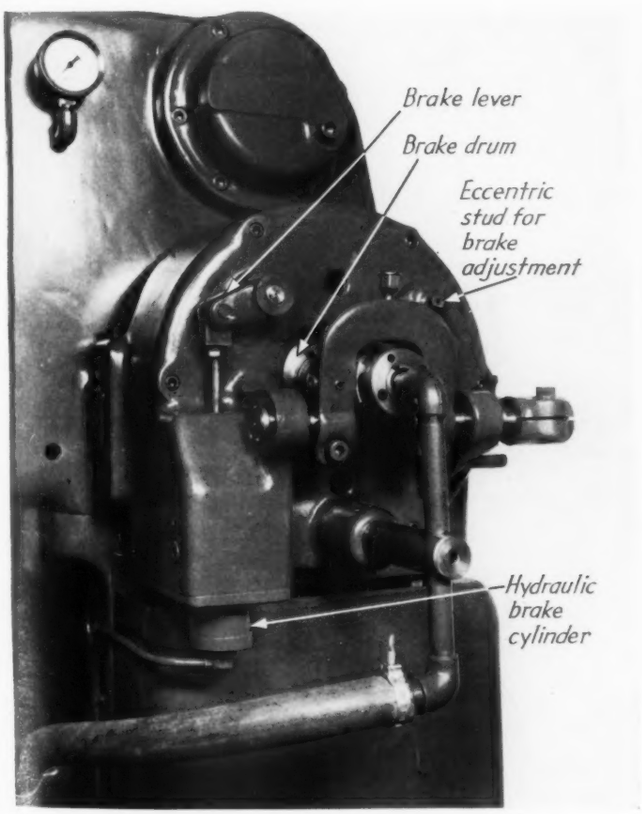
Automatic lubricating system supplies under pressure a metered amount of oil to each important bearing, assuring the presence of the proper oil film at all times when the machine is in operation, thus avoiding metal to metal contact that might through wear on sliding and rotating surfaces cause misalignment of the machine. At the back of each end of the machine, accessible to the operator, are pressure gages with relief valves for adjusting the pressure in the lubricating line. A filter is included in the lubricating system for removing foreign matter which may get into the lubricant.

The ball bearings in the work head are lubricated by two sight feed oilers. Two sight feed oilers on the front of the wheel slide lubricate the wheel spindle. The work spindle jack shaft is lubricated with machine oil or light grease with a pressure gun.

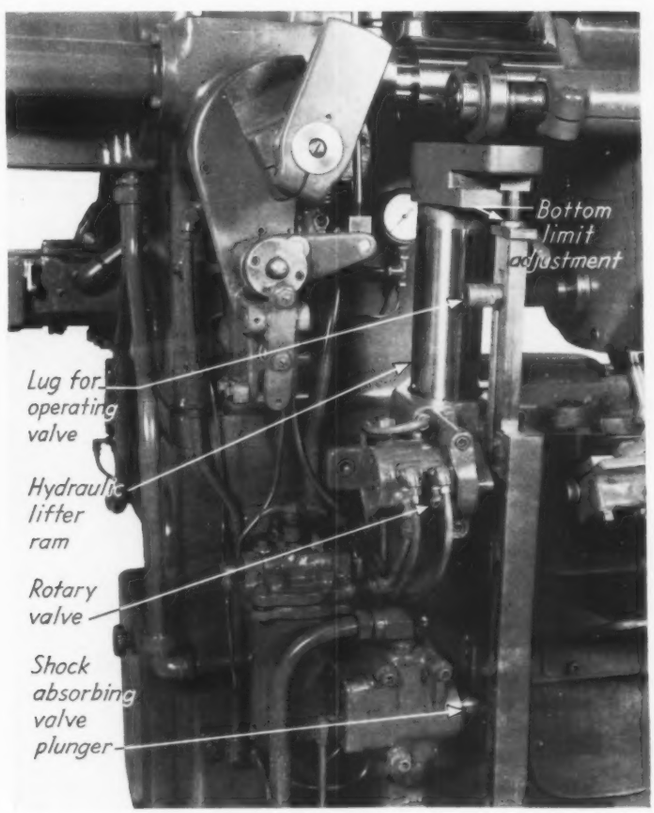




Hydraulic cylinder with telescoping guard sleeves traverses the wheel slide longitudinally. The wheel slide is connected to a rack which meshes with a gear on the stop wheel. The stop wheel carries adjustable cams for operating the valves in the valve block which control the direction of flow of the hydraulic fluid in the double acting cylinder. The cams on the stop wheel can be set so that the wheel can grind up to a shoulder. The cams also control the length of traverse and its position. The amount of dwell at the ends of the grinding operation is adjustable. For the operator's convenience in setting up the machine and while adjusting the cams to suit the work, the slide can also be traversed by hand with a crank handle which turns a shaft carrying a pinion, the pinion mates with an internal gear in the stop wheel.

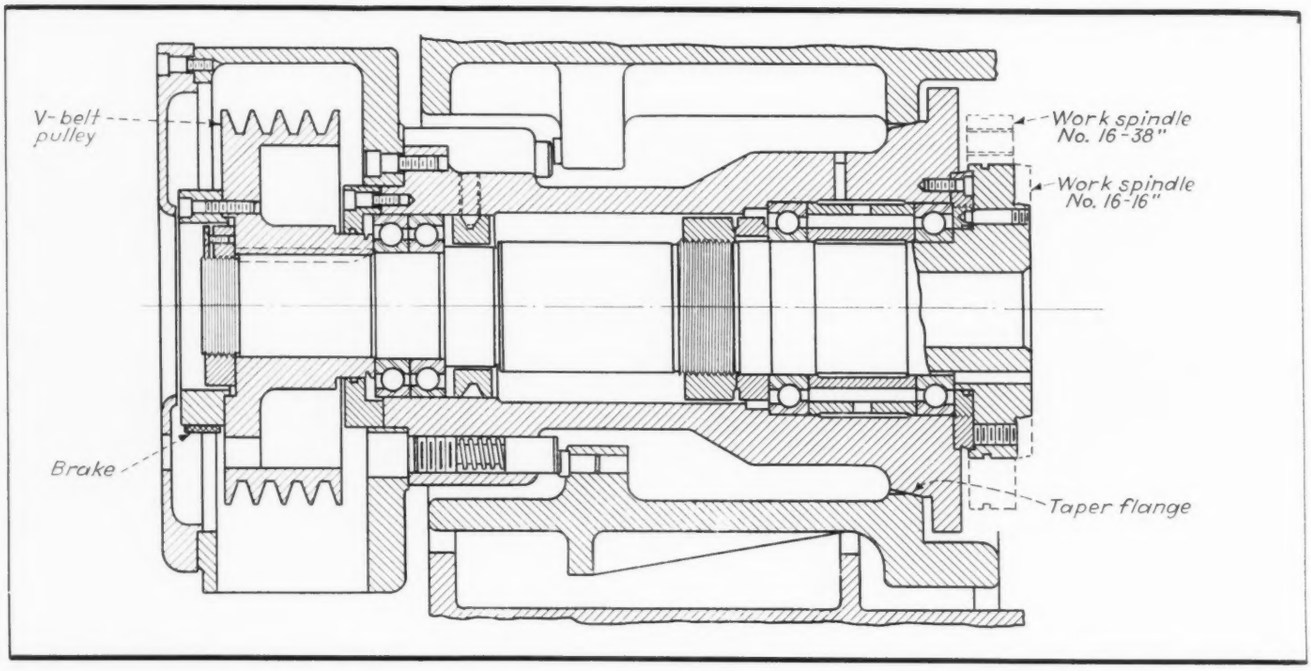


Friction band type brake on work spindle is operated by means of a hydraulic cylinder automatically controlled through the main valve block and cams on the stop wheel shown at top of this page. When the grinding wheel is withdrawn from the work, the brake stops the rotation of the work spindle. The brake is automatically released when the wheel again approaches the work. A hand valve for releasing the brake at any time is also provided.



Hydraulic lifter automatically swings the wheel slide head into positions for chucking, hole grinding and face grinding. The lifter is also used to swing the wheel slide head clear of its operating position. Interlocks render the lifter inoperative except when the slide is in the rear position. A throttling arrangement is provided so that the wheel slide drops back without shock into the grinding position to begin a cycle of operations on a new piece. ***(Continued on next page)***

Hydraulic Lifter Swings Wheel Slide on Chucking Grinder (*Continued*)

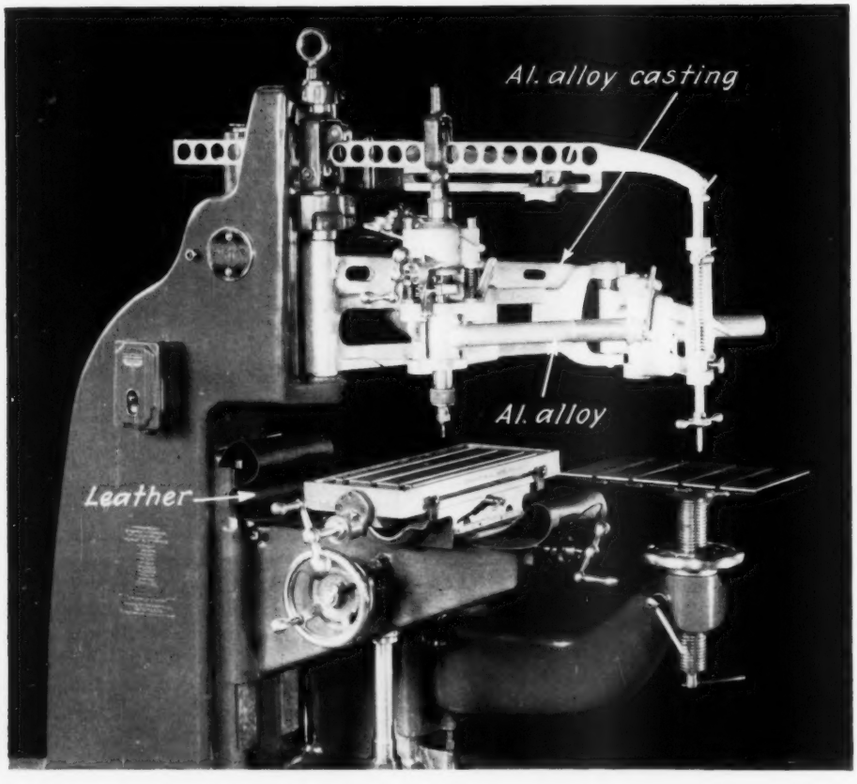


Work head spindle is mounted on preloaded ball bearings which are protected against abrasive material and the coolant solution. The work end of the spindle is flanged, the pilot has a slight taper with a "draw" to accurately center the chuck or face plate in spindle. Work head is driven by V-belts to obtain smoothness and to reduce vibration.

Yoke, sliding collar and lever for operating the chuck, also the method used for carrying the coolant to the work through the work spindle is shown in the view of the hydraulic brake on the preceding page.

Adjusting screws at back of machine are provided for aligning the work spindle assembly with the wheel slide.

Aluminum Castings in Pantograph Unit



Inertia forces have been reduced in the pantograph unit of the Gorton 3-L machine, by the substitution of aluminum castings and parts for cast iron and steel parts, thus increasing the sensitivity of cutter response to slight changes of shape in the model or template. This feature is important when the machine is used for accurately reproducing dies and molds which are used for making precision parts. The substitution of lighter for heavier metals cut down the weight of the unit from 181 to 81 lb., so that ease of handling by the operator was also improved.

Spindle assemblies are of hardened alloy steel with preloaded ball bearings.

Intermediate stepped-pulley, between motor and cutter spindle, is supported by adjustable swing arm connected to frame with a clamp joint; a turn buckle stiffener rod holds the intermediate pulley at a distance from cutter spindle to suit belt tension. The driving motor is mounted on a counterweighted swinging base.

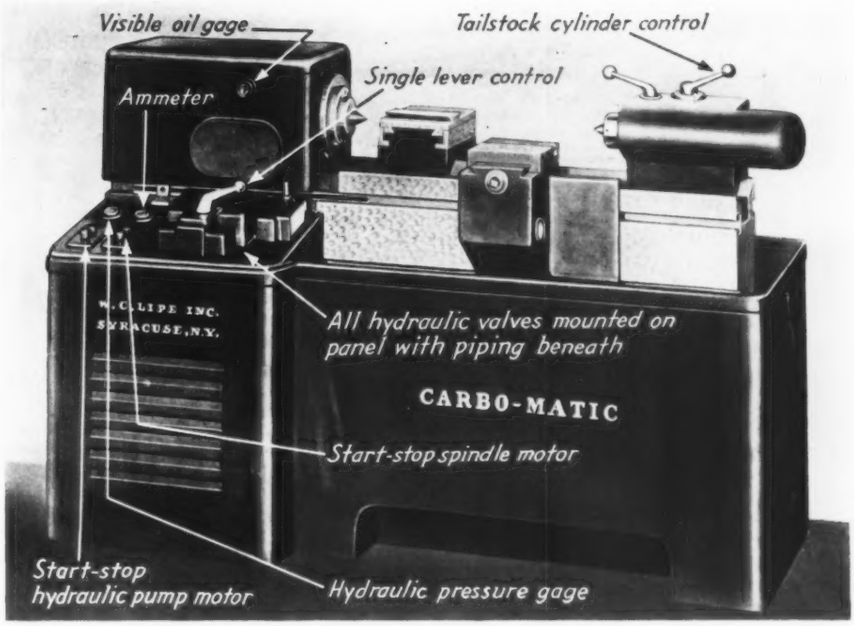
The ways are protected and kept clear of chips by leather aprons fastened to table, frame and knee of the machine. A spring wire support holds one apron off the traverse handle.

Carriage and Chuck Hydraulically Operated

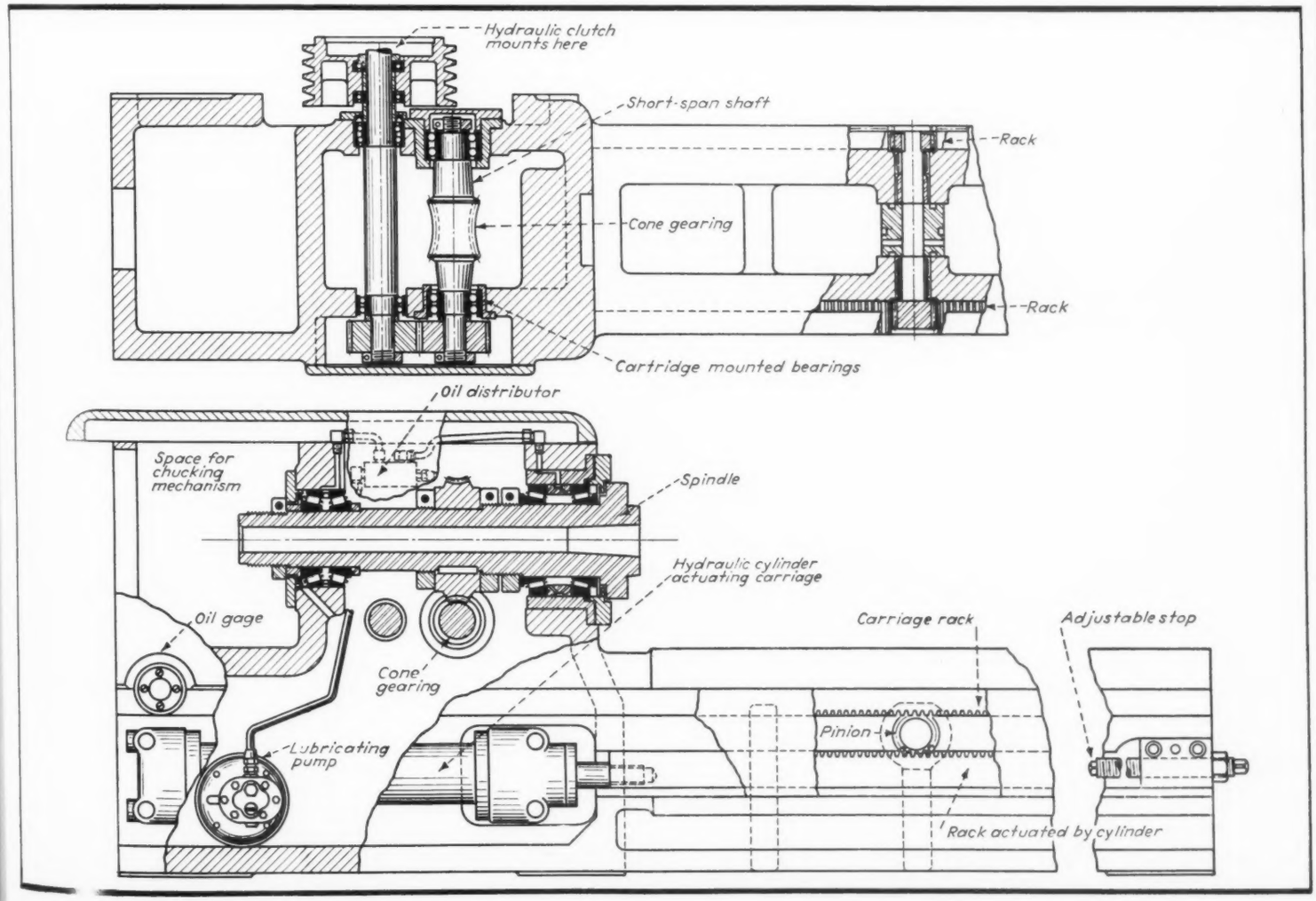
TO minimize vibration and tool breakage the new hydraulically-actuated W. C. Lipe Carbo-matic precision lathe, designed to use high-speed carbide tools, has all castings poured from a nickel-chromium alloy iron containing a large percentage of steel. Castings are heat-treated between roughing and finishing operations. Cone worm gear drive reduces backlash. The heavy spindle, with minimum overhang, is mounted on cartridge type Timken precision ball bearings. Headstock and bed are integral.

An outboard bearing supports clutch unit preventing misalignment of pulley shaft on overload. All clutch pulleys and pulley shafts are ball bearing mounted. Center to center distance of bearings on main shafts supporting Cone gearing is kept to a minimum.

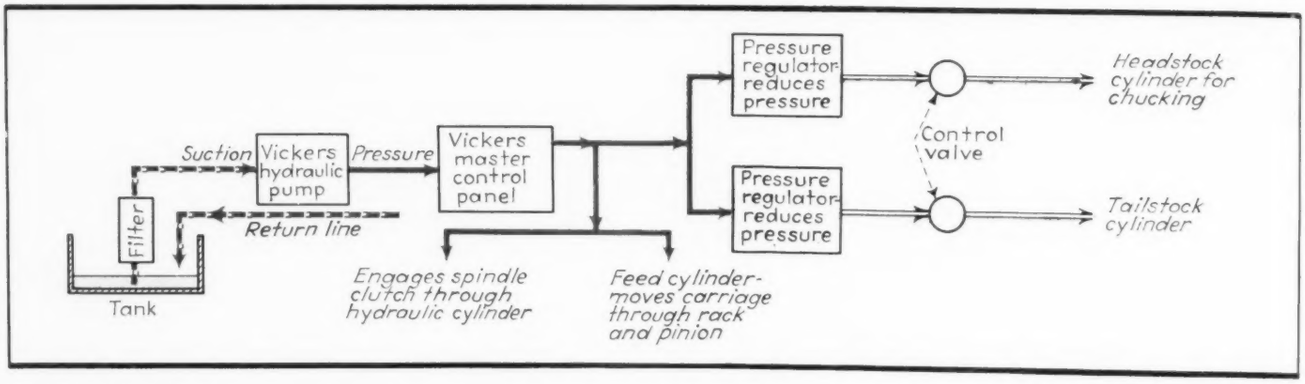
Bearings and worm gearing are lubricated by a built-in gear pump supplying oil under 10 lb. pressure from a 7 gal. supply tank housed in machine base. The vane-type coolant pump is interlocked with the spindle start-stop controls. A Bijur unit, mounted on the front carriage, supplies a metered amount of oil to moving parts on each stroke.



Controls are mounted on a single, inclined panel; valves can be removed without disturbing piping below. 110 v. current is supplied through built-in transformer. *(Continued on next page)*

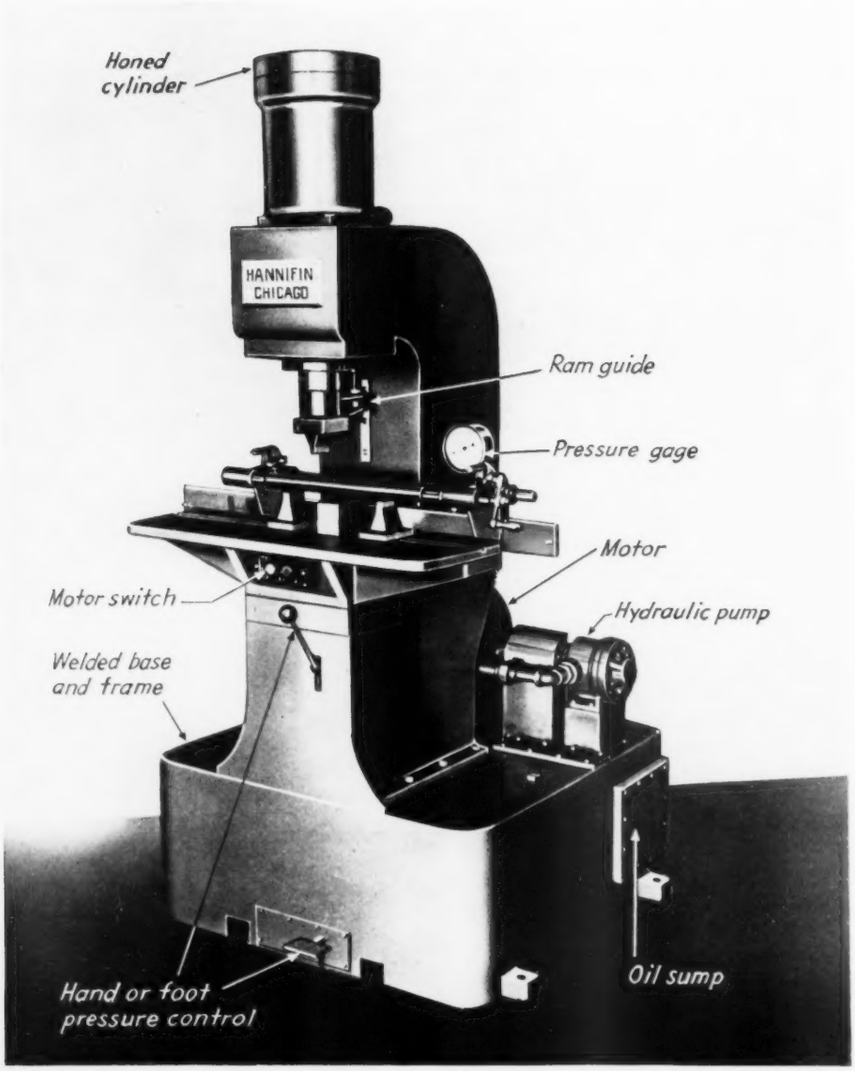


Carriage and Chuck Hydraulically Operated *(Continued)*



Single control lever governs principal hydraulic movements. Downward movement of the lever engages spindle clutch and also advances tool carriage which is operated by rack and pinion impelled by a hydraulic cylinder. At end of cut, carriage moves against positive stop, where it is held for a period of time by a hydraulic time delay valve. At completion of delay, tools pull away, spindle clutch disengages, carriage returns to load position rapidly and entire machine stops. Tailstock and chucking mechanisms are operated by built-in cylinders and controls.

Variable Pressure Control Used on Hydraulic Press

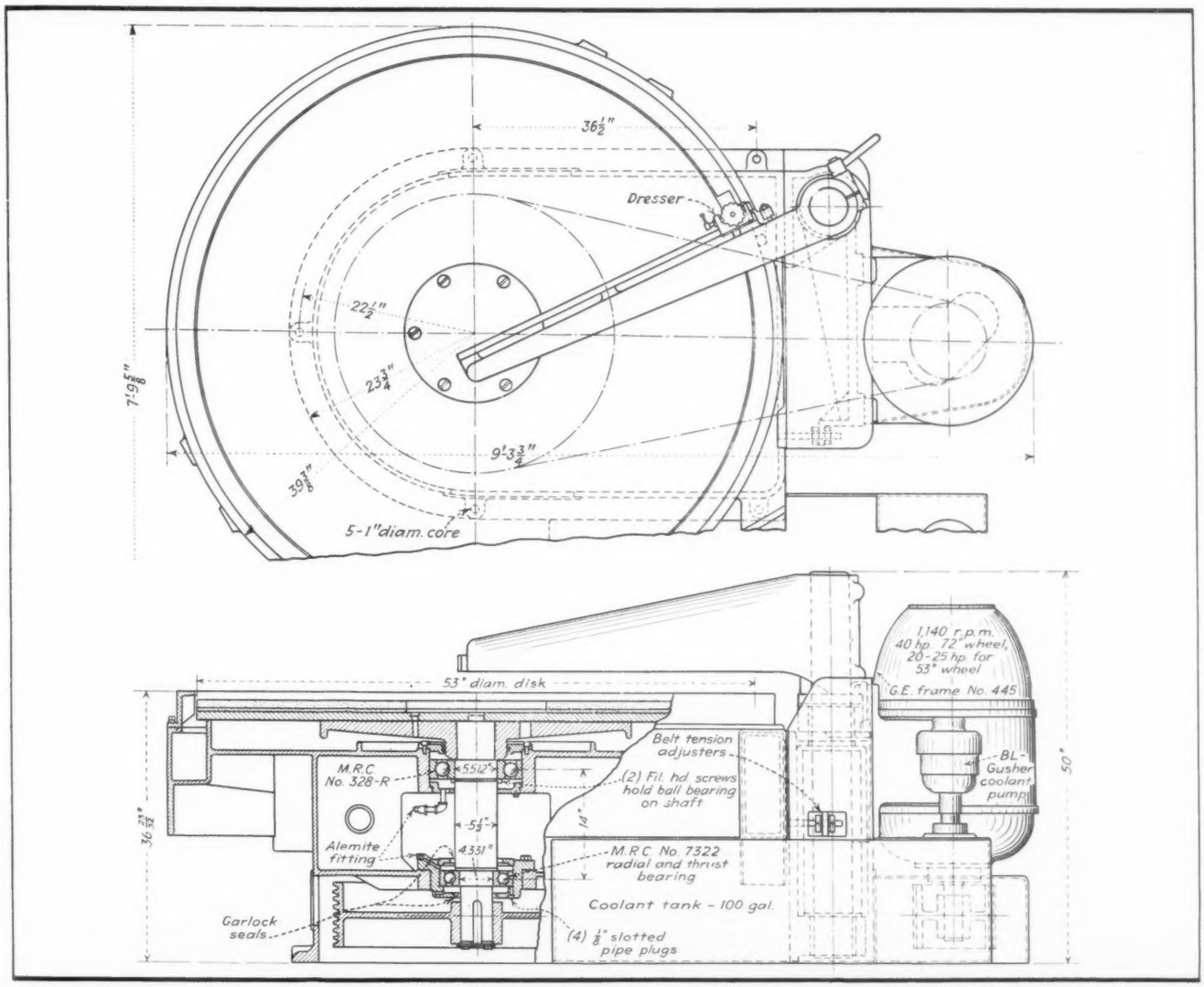


Infinitely variable pressure control from zero pressure up to capacity of the press is a recently developed feature for use on Hannifin hydraulic presses. Instead of controlling distance of ram travel, the working force exerted by the ram is under direct and sensitive control of foot or hand operated Hannifin control valve. The initial downward motion of the lever (within first inch of its travel) allows low pressure in cylinder to bring ram down to the work. Remaining motion of lever applies pressure in direct proportion to distance the control lever is moved. Gage is graduated in tons pressure, furnishing a simple guide for operations requiring a specific minimum or maximum pressure.

Releasing control lever at any point automatically returns ram to top position at high speed. Unnecessary ram travel can be avoided by adjusting ram stroke to suit maximum gap required for the specific job. Oil pump idles at zero pressure between operations.

Automatic inspection on pressing jobs is another feature of these presses. Where certain maximum and minimum pressures have been determined for a specific production press assembly job, an indicating light and pressure relief valve arrangement is used. When minimum pressure required for tight fit of parts has been exceeded an adjustable pressure valve closes a switch, turning on a light to indicate that parts are not too loose for satisfactory assembly. If parts fit too tightly, the maximum setting of the stop will not permit application of more than a certain amount of pressure; the tight parts can not be forced into place, assembly is automatically rejected.

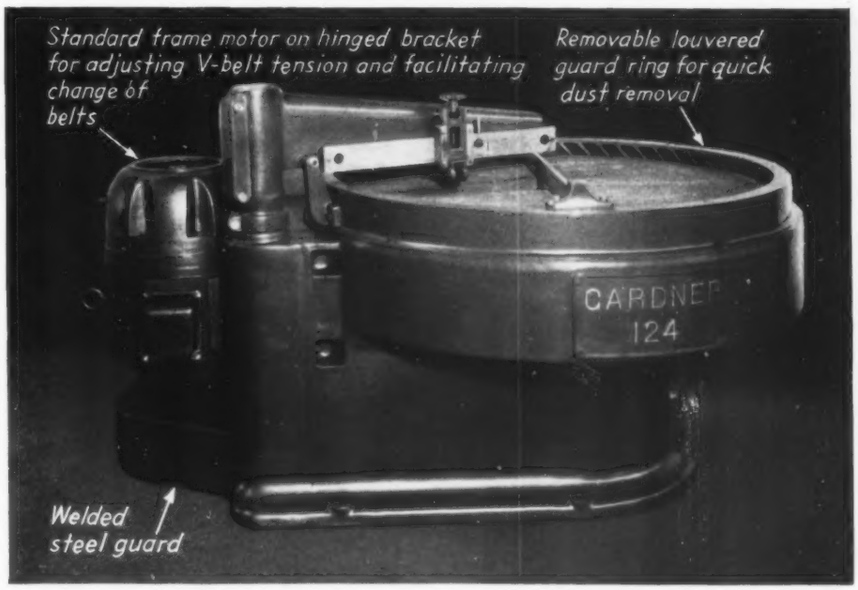
Disk Grinder with Louvered Guard Ring



Standard frame ball-bearing motor is mounted on a hinged bracket which can be swivelled by turning an adjusting screw, thus tightening or loosening the multi-V belts to compensate for stretch or to replace belts, respectively. Bracket-hinge pin is a 4-in. diam. shaft, assuring rigidity. Welded sheet-steel guards, easily removable, completely inclose drive. Belts can be replaced easily by removing the guard and taking off a hand-hole cover at the front of the base.

Spindle speed is 450 r.p.m. Bearings in waterproof housings are lubricated through pressure type grease fittings. The lower ball bearing has a rated load-carrying capacity of 21,300 lb.

Base of machine is alloy cast iron as is the removable louvered guard ring. Louvers are flush with the edge of the steel wheel and low enough to always be below the surface of the abrasive even when abrasive is worn thinnest, so that pieces being ground can never jam. Angle of louvers, 45 deg., is designed to give quickest removal of dust.


Standard frame motor on hinged bracket for adjusting V-belt tension and facilitating change of belts
Removable louvered guard ring for quick dust removal
Welded steel guard
GARDNER
124

A special feature is the "Swinging Bar-type Dresser" pivoted on a 4-in. diam. shaft. Arm is inverted U-section and ribbed to give it desired stiffness.

MACHINE TOOL DRIVES, FRAMES AND BEDS

ONE of the most outstanding developments in electric drives has been that of variable voltage control for planers. The modern drive, more or less a further development of Ward-Leonard Control, has made available not only an extremely wide range of planer speeds but also a vast improvement in planer operation. The chief engineer of one planer company stated that the modern planer drive permits as high as 98 strokes per minute without shock at the ends of the strokes. The schematic arrangement of one such control is shown on p. 446 of this number.

With further reference to electrical equipment designers of machine tools are making a vastly greater use of limit switches and electrical interlocks between the hydraulic and electric systems. The aim is to make the complete operation of the machine entirely foolproof and to a great extent automatic. Even the lubricating circuit in some machines is interlocked with the main electric drive circuit so as to make it impossible for the machine to operate if the lubricating oil in the system is not at the required pressure. Excessive pressure such as might be caused by clogged lubricating pipes or a deficiency of pressure such as might be caused by lack of oil will, in either case, cause the pressure switch to shut down the main driving motor. In the design of the La Pointe vertical broaching machine a float switch in conjunction with the lubricating oil reservoir prevents the machine from operating unless a sufficient supply of oil is in the reservoir.

Further in conjunction with electric drives, more machine tool builders are incorporating ammeters. The purpose is to give an indication when the tools have been dulled to a point where they should be taken out and replaced. Such a use of an ammeter has been found especially valuable in the design of a New Britain Gridley automatic machine, the ammeter making it possible to pick which of the tools has become dull.

Perhaps the most striking example of the application of electrical automatic control units to machine tools is found in the Monarch full-automatic lathe. In this machine limit switches control the complete cycle of movement, making it possible to have the machine operate fully automatic, the only attention required of the operator being that of taking out the finished pieces and chucking the work to be turned.

Most machine tools and beds are cast although some designers use welded construction practically throughout, notably in hydraulic broaching machines. Even some engineers who adhere most closely to castings, specify flame cut welded steel frames for small-lot production. The higher machining cost is offset by the savings in pattern costs and the smaller amount of material required. Pattern saving however vanishes upon quantity production. Higher damping factor also favors cast iron in tools wherein vibration is an important consideration.

Welded frames and bases are usually made up of flame-cut plates and shapes. Because designs are calculated for stiffness, stresses are low, hence strengths of the welds are not a governing factor. Therefore at the corners of welded columns and similar constructions the one plate need not overlap the edge of the other and be welded on both sides. The inner edges of the two plates are butted and the 90 deg. V that is formed is welded. The appearance of the joint is also improved.

Most cast frames are alloy cast iron with 30 to 60 per cent steel scrap, old railroad rails being preferred because of their uniformity in carbon content and clean metal. Nickel and chromium are usually added for toughness and machinability, giving tensiles of 50,000 lb. per sq. in. and higher. Many engineers specify Meehanite especially where high strength, toughness and good dense machined surfaces are required. All iron castings specified by Cincinnati Milling Machine Company engineers are Meehanite.

For lightness, cast aluminum or resistance welded sheet steel covers are being used. At least two manufacturers have standardized on zinc die-cast handwheels. Beryllium copper has been found ideal for stops and dogs. Expanded metal and sheet perforated screens are being used for protection over woven wire screens.

For steel ways, engineers are using S.A.E. 3170 with 0.20 Mo addition and oil hardened to 55–60 Rockwell C; S.A.E. 3140 flame hardened on top and sides; S.A.E. 1020 or 3115 carburized and hardened to 58–61 Rockwell C; tool steel welded or cast on a low carbon ingot and rolled. Cast iron, flame hardened, is a distinct trend.

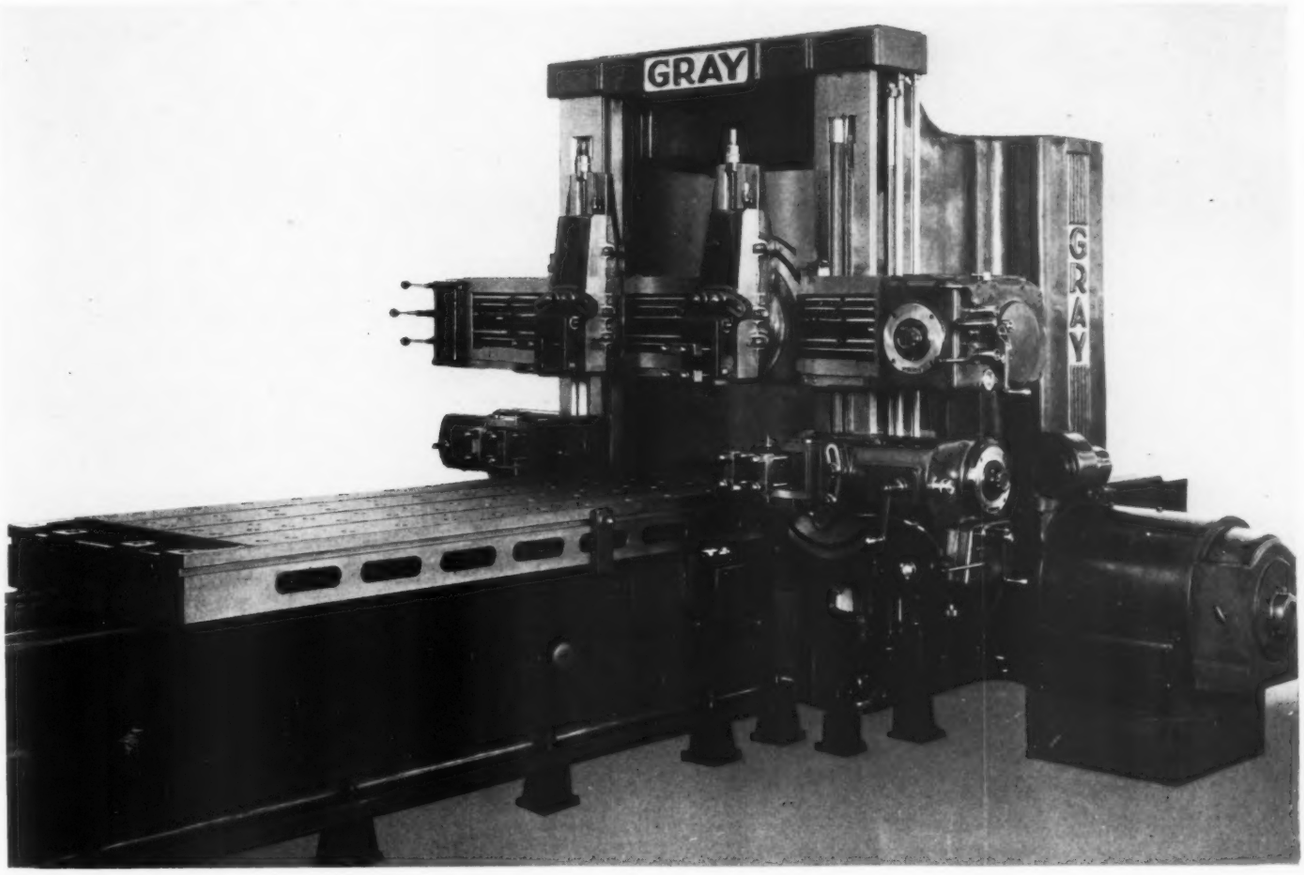
Oil hardened gears are of S.A.E. 3150, 3250, 2345, 4150, 6150, hardened to 45–50 Rockwell C; carburized gears are of S.A.E. 3120, 2315, 2515, 3312, 6112 or 4620, the last being popular because of its low distortion from heat-treatment. Latest trend that is rapidly becoming more popular is rim hardening by means of the oxyacetylene flame.

To compensate for the slight distortion when flame hardening bars, one manufacturer gives bar a slight bend in opposite direction before the bar is flame hardened.

Splined shafts use S.A.E. 4340, rough machined, hardened to 400 Brinell and then finished machined. S.A.E. 3140, 4140 and 6140 are also used, hardened to 310 Brinell. Where maximum strength is required, S.A.E. 3250 and 2345, finished machined and heat-treated to 350–450 Brinell are specified by at least one engineer.

Studs and bolts may be S.A.E. 2330 or 3135, heat-treated to 269 to 311 Brinell depending upon service factors.

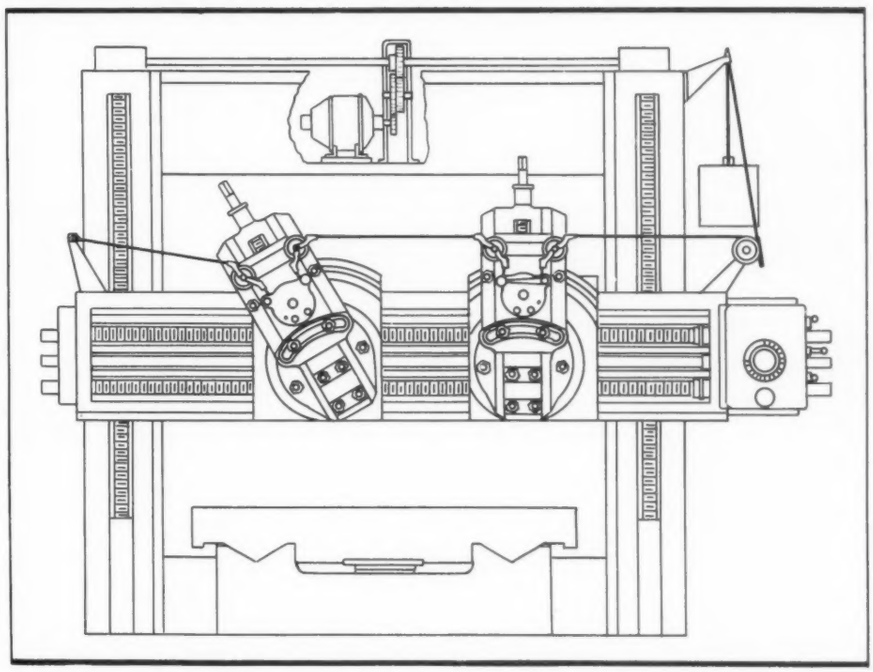
Drive, Feed and Lubrication on Gray Planers



Variable voltage motor drive, of the type described on page 446, gives table reversals up to 90 times per minute, table speeds up to 300 ft. per minute. Design of table drive gives inherently smooth table travel, and has a long wear life without loss of accuracy. At the high speeds and heavier table loads, lubrication of the table ways also became an important consideration. Other outstanding design improvements in Gray planers include the positive feed, power swivelling of the rail heads, rail counterweights placed inside the housing, and safety interlocks.

All these features also apply to the Gray planer-type milling machines. The column of the openside planer type milling machine is of triangular cross-section, giving it unusual stiffness, much greater than obtained in an equivalent rectangular section wherein the metal at and near the corners of the section has little or no value for resisting torsional loads. The column is of uniform cross-section from top to bottom and throughout has internal braces cast integral with the column to increase its stiffness.

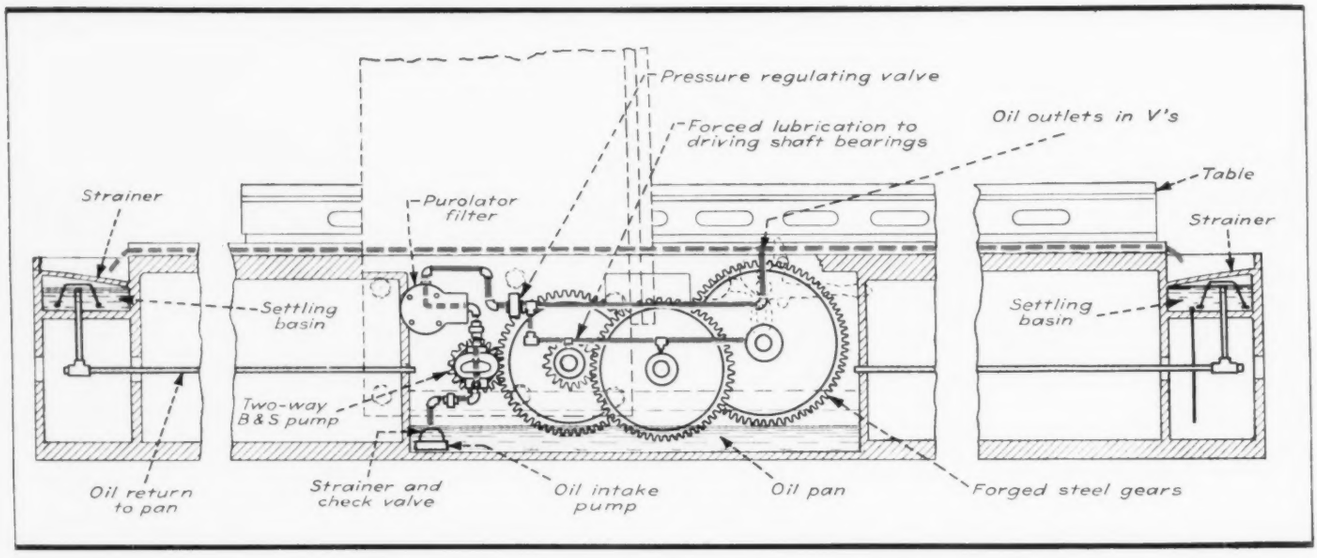
Another feature is the ball-bearing spring counterbalance which relieves the saddle gibs of all weight, thus prolonging the accurate life of the rail and making the heads easier to move across the rail with a saving in power.

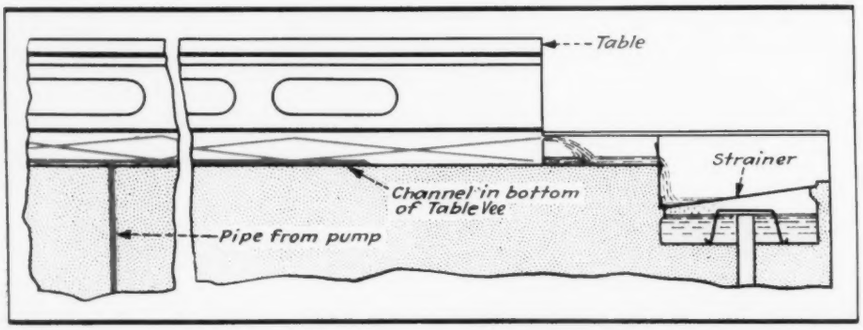


Power swivelling of the rail heads is accomplished as explained by the notations *A*, *B* and *C* in the illustration on following page. Power rapid traversing of saddle along the rail causes the clamped cable to rotate head on the saddle trunnion. Final accurate setting is done by inching the saddle. Purpose of counterweighting the slides was to take up backlash and reduce wear between slide nut and its feed screw. By over-counterweighting backlash is always taken up in the direction of the tool-pressure thrust.

(Continued on next page)

Drive, Feed and Lubrication on Gray Planers (*Continued*)

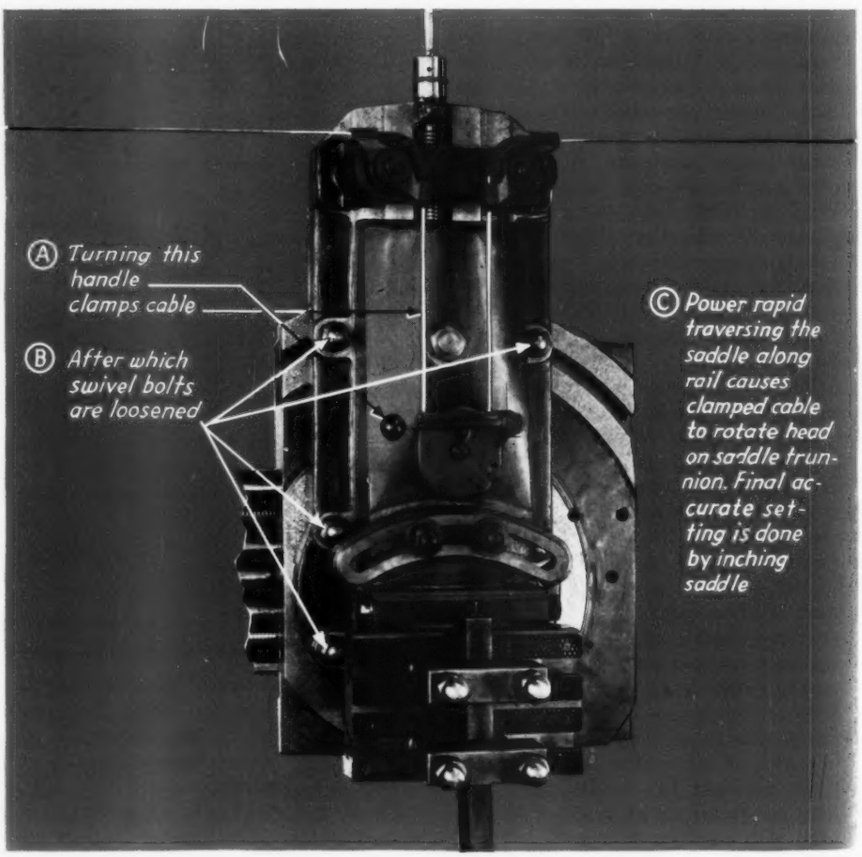


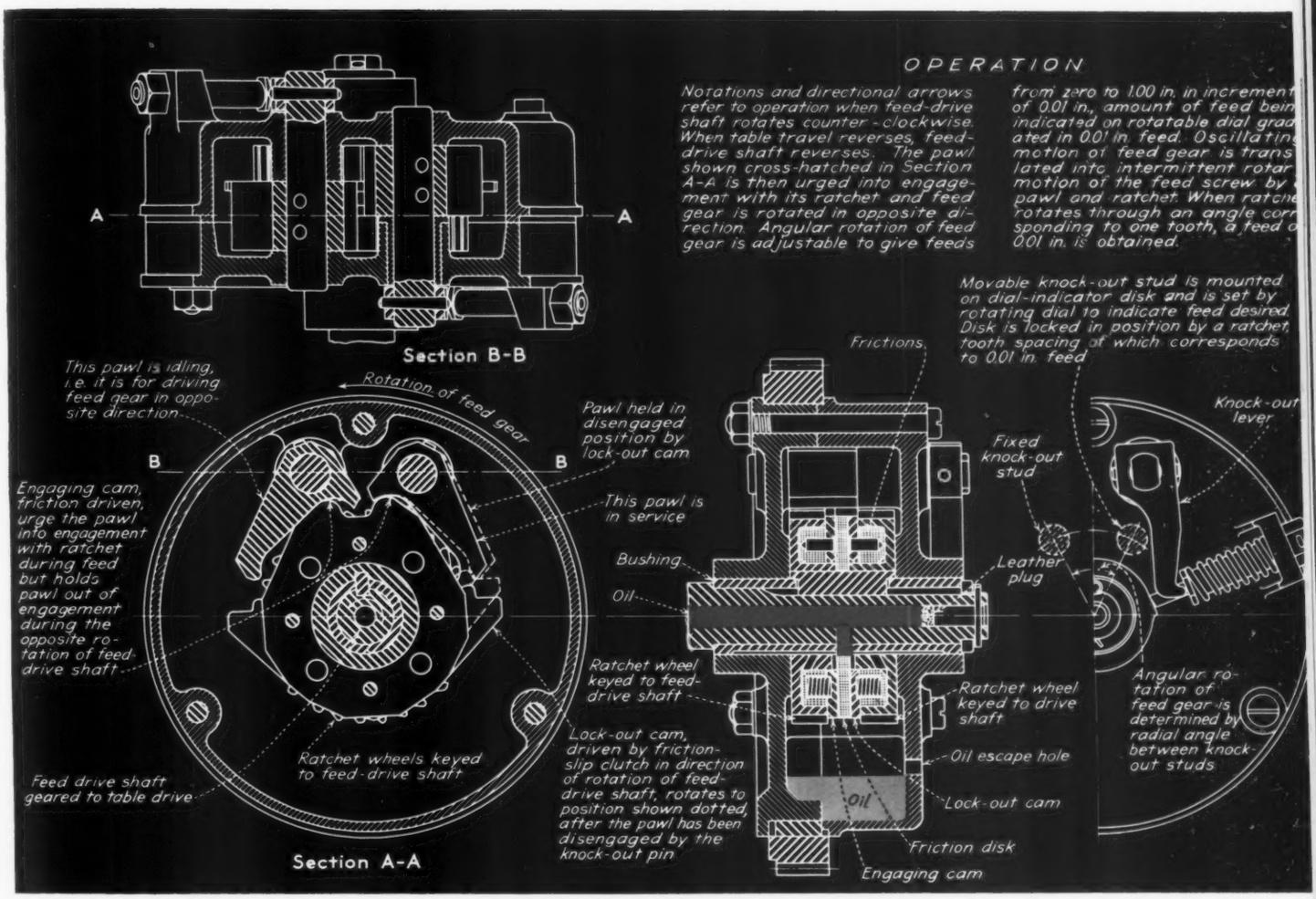


Lubrication of the planer bed ways and table vees give a flood of oil over the entire surface of the table vees. Oil under pressure fills the channel cut into the bottom of the table vee and extending not quite to the ends of the table. As the table never overhangs, the channel will always be open to the oil supply pipe and the ends of the channel will be sealed. The channel serves as a manifold and reservoir which supplies oil under pressure to the oil grooves cut in the table vee and the continuous flow streams out through the oil grooves at the end.

Lubricant. Gargoyle Etna Oil Heavy Medium or similar high quality lubricant is recommended—is pumped from oil reservoir by a two-direction gear pump driven off the main drive. Gear pump that pumps in both directions of rotation was required so that pump would deliver oil continuously, that is, during both directions of table travel. After passing through the Purolator filter the oil goes through a pressure regulating valve and to the ways as shown in the lubrication diagram. The oil streaming out of the ends of the table vees washes the surface of the bed vees and flows to the collecting pans at each end of the bed, carrying all impurities with it as the oil is pushed in a wave by the action of the returning table. Strainer plate in bottom of collecting pans takes out coarse foreign matter. Finer particles are filtered out by Purolator filter. Oil need never be removed, it being merely necessary to replenish oil to replace losses from evaporation.

Power-swivelling of the head is explained in the illustration to the right. See illustration on preceding page for the arrangement of the cable and counterweight. Notations *A*, *B* and *C*, taking in order, explain in detail the manner in which the head can be power-swivelled to any desired angular position.


Ⓐ Turning this handle clamps cable
Ⓑ After which swivel bolts are loosened
Ⓒ Power rapid traversing the saddle along rail causes clamped cable to rotate head on saddle trunnion. Final accurate setting is done by inching saddle


OPERATION
Notations and directional arrows refer to operation when feed-drive shaft rotates counter-clockwise. When table travel reverses, feed-drive shaft reverses. The pawl shown cross-hatched in Section A-A is then urged into engagement with its ratchet and feed gear is rotated in opposite direction. Angular rotation of feed gear is adjustable to give feeds from zero to 1.00 in. in increments of 0.01 in., amount of feed being indicated on rotatable dial graduated in 0.01 in. feed. Oscillating motion of feed gear is translated into intermittent rotary motion of the feed screw by a pawl and ratchet. When ratchet rotates through an angle corresponding to one tooth, a feed of 0.01 in. is obtained.
A
A
Section B-B
Movable knock-out stud is mounted on dial-indicator disk and is set by rotating dial to indicate feed desired. Disk is locked in position by a ratchet, tooth spacing of which corresponds to 0.01 in. feed
Frictions
This pawl is idling, i.e. it is for driving feed gear in opposite direction
Rotation of feed gear
Pawl held in disengaged position by lock-out cam
Knock-out lever
Fixed knock-out stud
B
B
Engaging cam, friction driven, urge the pawl into engagement with ratchet during feed but holds pawl out of engagement during the opposite rotation of feed-drive shaft
This pawl is in service
Bushing
Leather plug
Oil
Ratchet wheel keyed to feed-drive shaft
Ratchet wheel keyed to drive shaft
Angular rotation of feed gear is determined by radial angle between knock-out studs
Lock-out cam, driven by friction-slip clutch in direction of rotation of feed-drive shaft, rotates to position shown dotted, after the pawl has been disengaged by the knock-out pin
Oil escape hole
Ratchet wheels keyed to feed-drive shaft
Feed drive shaft geared to table drive
Oil
Lock-out cam
Friction disk
Engaging cam
Section A-A

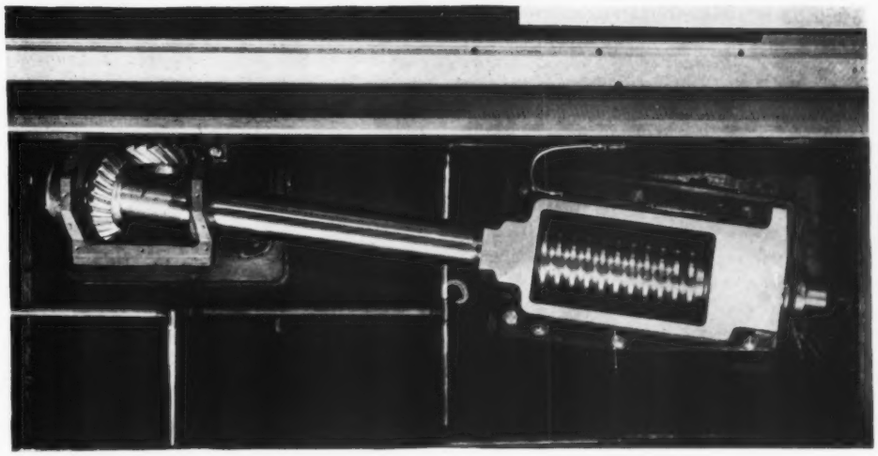
Feed mechanism operation is explained in the notations on the diagram above.

The dial plate on which the movable knock-out stud is mounted is locked in position by a ratchet. A rotation of one ratchet tooth-pitch increases or decreases the feed 0.01 in.

Not shown on the diagram is the drive from the feed gear to the feed screw, which is through gears and a ratchet. The pitch of the ratchet teeth is such that one tooth-pitch travel gives a feed of 0.01 in. Thus any feed from zero to 1.00 in. in steps of 0.01 in. is obtained.

Feed adjusting dial can be set while the planer is in motion. Feed of the head across the rail or vertically on housing can be made to take place at either end of the table travel to suit the work.

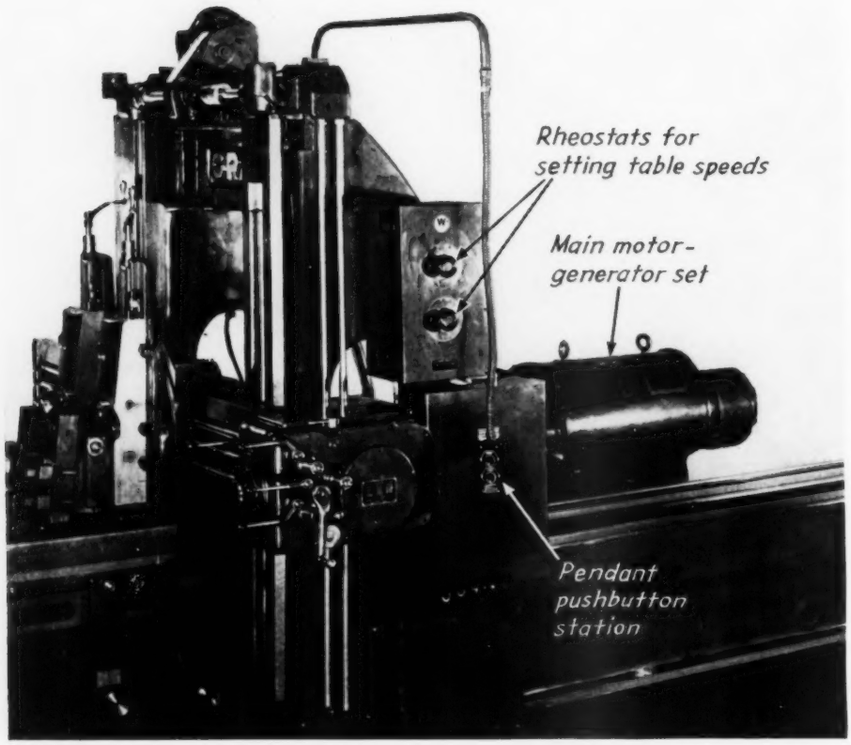
A highly ingenious safety feature is the design of the handle for feeding by hand. The hub of the handle has on its inner face a multiple-tooth jaw clutch. Upon engaging either power feed or power rapid traverse a jaw clutch on the inner face of the hub of the handle is disengaged by a cam and the handle is then supported on a non-rotating sleeve and has no contact with any rotating part. This makes it impossible for the handle to spin during power feed or rapid traverse.



Angular hypoid gears made possible a driving shaft of larger diameter and yet able to pass under the guide way of the bed. Also permitted driven shaft between angular hypoid and spiral pinion to be mounted higher in the bed, increasing bed stiffness and putting the line of action of the table-driving force nearer to the working surface of the table, reducing tendency to lift table.

Spiral pinion drive of milling machine table makes the side thrust on the table practically a negligible amount because the effect of the lead of the spiral pinion is almost entirely compensated by the angle of the pinion shaft. The Gleason hypoids are of forged alloy steel, heat-treated and hardened to obtain the desired physical properties and are inclosed in separate housing so that they can be specially lubricated with the Extreme Pressure lubricant as required for hypoid gears. Because self-locking takes place between the table rack and its spiral pinion, possible backlash between table and drive is minimized, it being confined only to the clearance between the rack tooth and the spiral pinion tooth.

Variable Voltage Regulation for Planer Drive

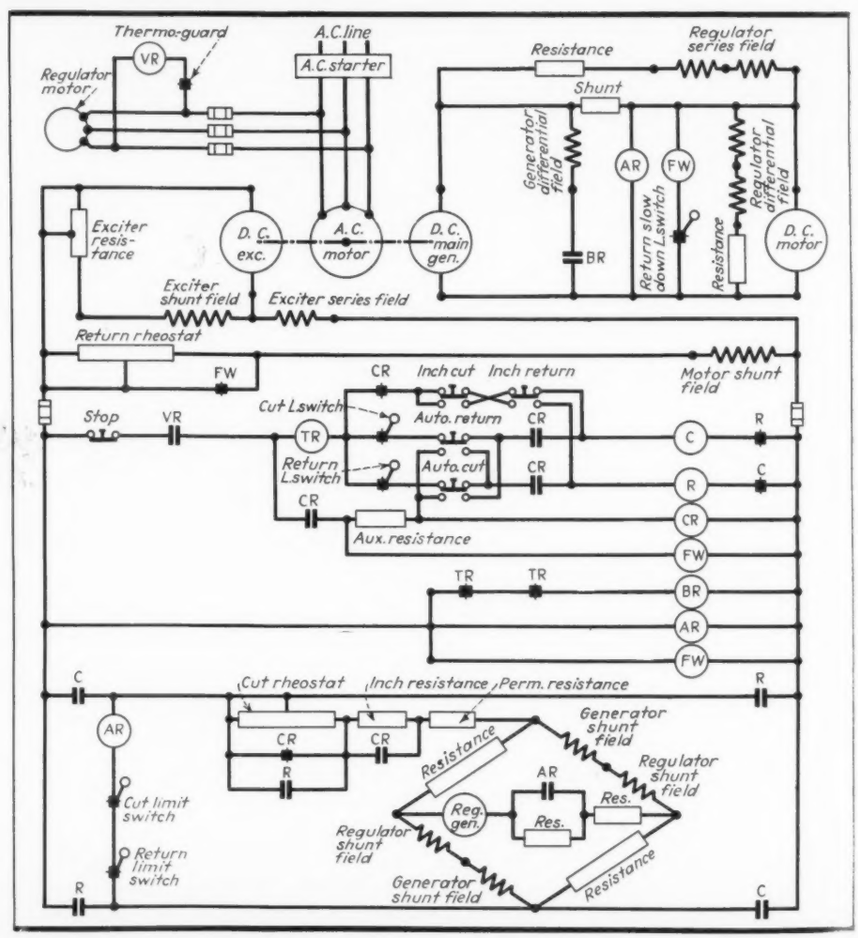


Westinghouse variable voltage planer drive is designed to provide large speed ranges, stable operation at all loads, and rapid platen reversal. It consists of a main motor-generator set, reversing planer motor, magnetic controller with few relays and contacts, and a small regulator motor-generator set mounted in the control box. Cutting speed range of from 40 to 750 r.p.m. is set by a rheostat which varies the main generator voltage. Return speeds of 750 to 1,200 r.p.m. are set by a rheostat in planer motor shunt field circuit. When the speed of the planer motor is correct for rheostat setting, the three field windings in the regulator generator balance each other. If load conditions tend to change speed, regulator generator fields become unbalanced and a voltage is generated which causes current to flow through the Wheatstone bridge circuit in the direction required to hold correct planer motor speed. Regenerative braking provides accurate and quick stop and reversal.

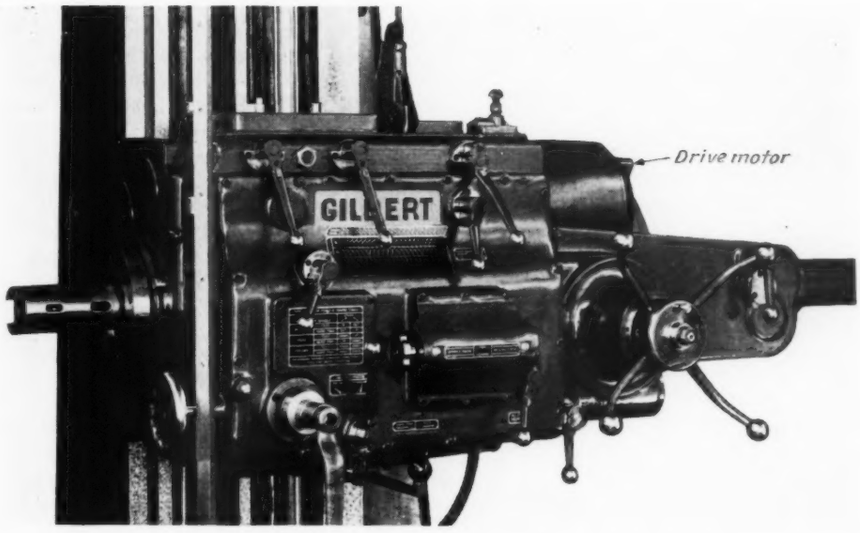
A pendant pushbutton station suspended over the operator's position contains buttons for starting, stopping, and reversing the table, as well as buttons for inching the table in either direction.

Automatic cut button energizes control relay coil CR, which in turn energizes coils TR and C. Relay C energizes main generator shunt fields, building up voltage and planer motor speed to value determined by cut rheostat. At end of cutting stroke, control dog contacts cut limit switch, deenergizing C and energizing R. This reverses voltage on main generator shunt fields, and causes planer motor and platen to reverse. TR contacts are held open by a time delay. When generator voltage reaches 200 volts, relay FW inserts return rheostat in planer motor field and motor continues its acceleration until return speed is reached.

Near end of return stroke, control dog strikes slow-down limit switch, deenergizing FW to cut out return rheostat. This builds up motor field strength and reduces platen speed. Dog then contacts return limit switch, reversing table for cutting stroke. The AR relay coil is deenergized at end of each stroke by limit switches, and contacts are held closed until voltage drops to 250 volts. On re-opening, AR changes resistance value of bridge circuit, forcing the main generator shunt fields and braking the motor. On power failure, stored energy in motor-generator set stops the machine quickly. In starting and stopping, relay coil BR connects main generator differential field across the armature, preventing creep caused by residual voltage in generator.



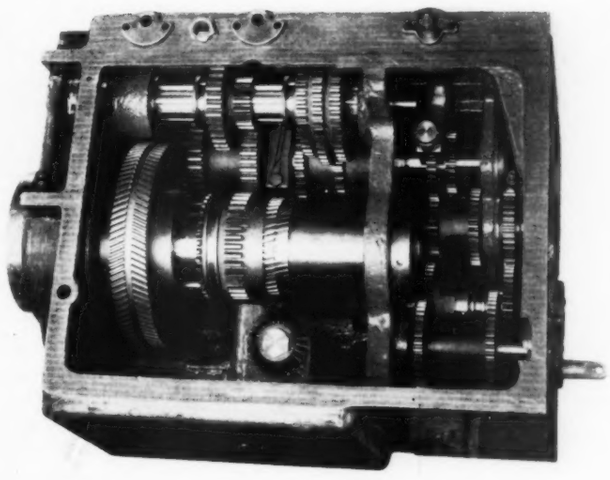
Compact Head Unit For Boring Mill

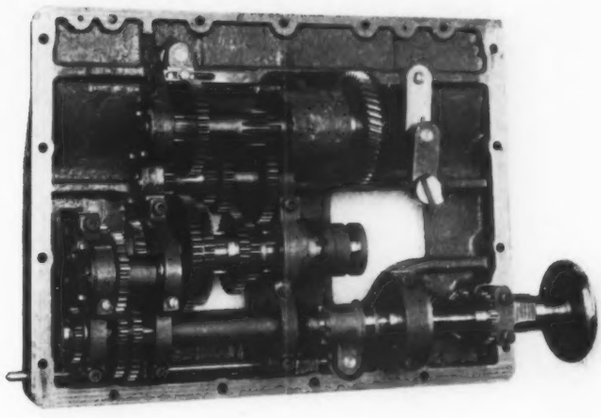


Box shaped castings, which form the head and horn of Cincinnati Gilbert Machine Tool Company's horizontal boring, drilling and milling machine, are ribbed so that all loads from the cutters and gearing are carried to the base of the head which fits on the column. The head is clamped to the column by a screw clamp acting in a double vee. Head is fully counterbalanced with weights placed inside of the column.

Head unit is an inclosed oil-tight assembly containing the spindle 24 speed-change mechanism, the feed unit, the rapid traverse friction clutch, hand adjustment to the spindle, the spindle and spindle sleeve, and also the lubricating system.

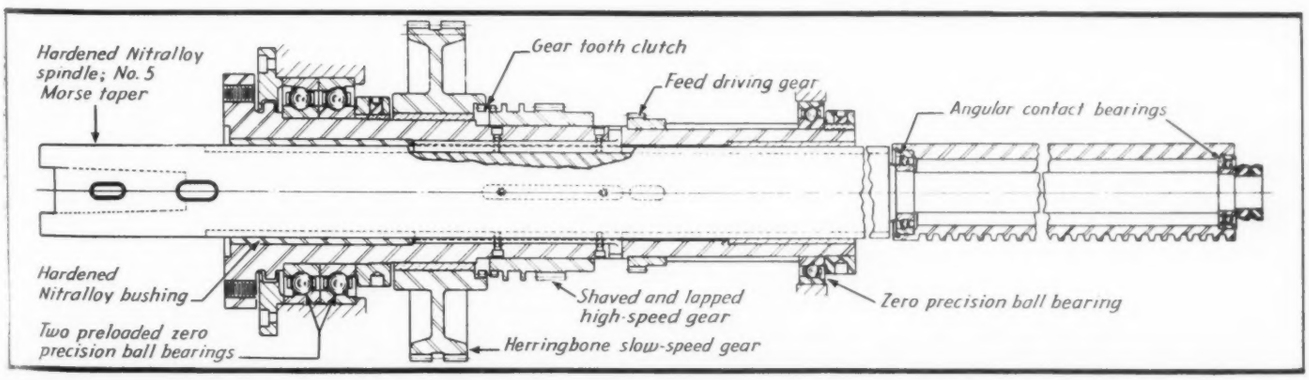
A reversible speed flanged type motor, mounted on the head, drives direct through spur gearing.





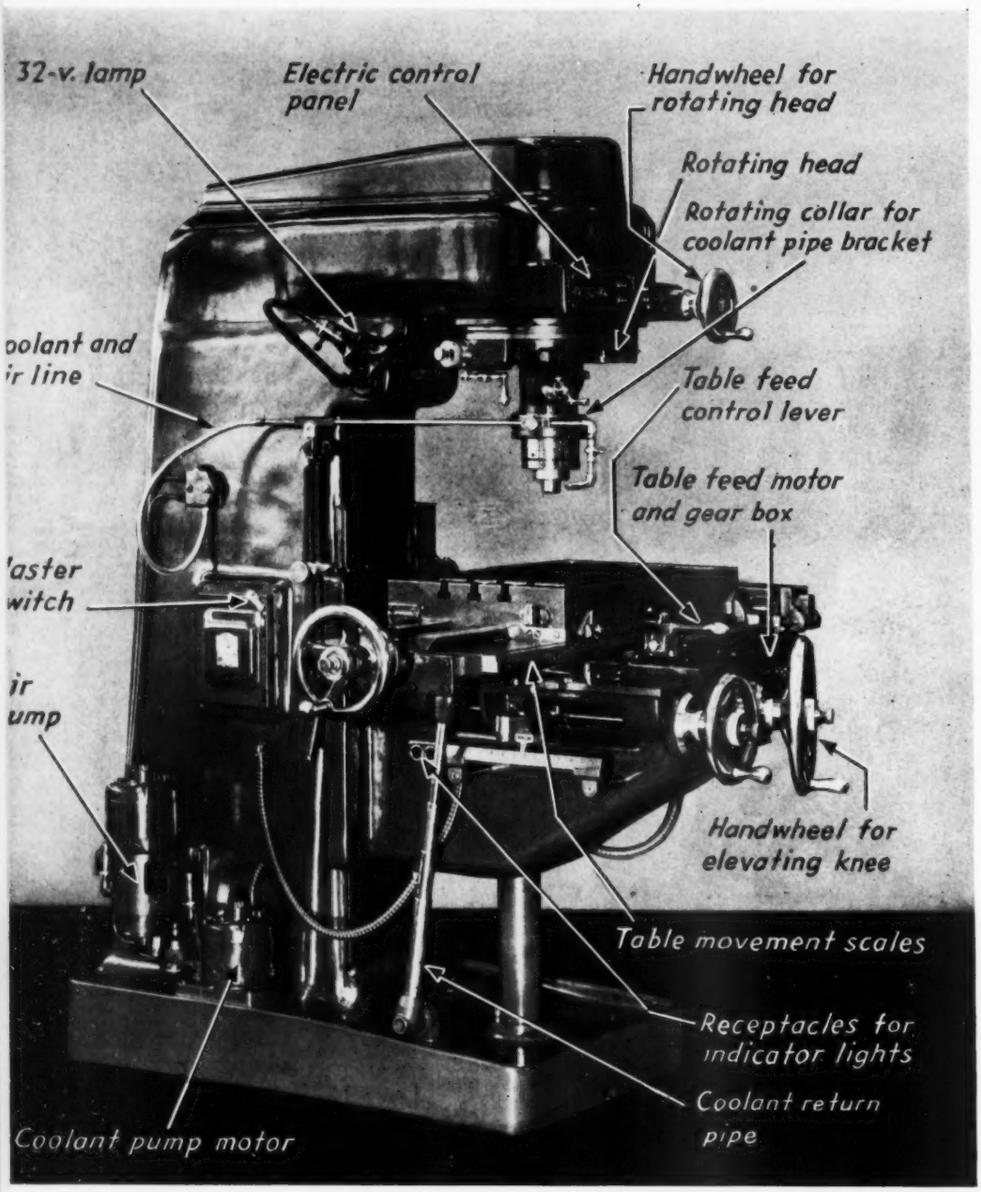
Sliding gears are used throughout the spindle speed change mechanism except for clutching the herringbone face gear. The clutch, located on the spindle sleeve is of the gear type. Gears slide on multiple splines which are hobbed from the solid, then heat-treated and ground. To secure hard, smooth wearing surfaces and quiet operation, gears are finished by cross shaving after carburizing. After hardening the gears are cross lapped.

Feed mechanism, which is mounted on the inside of the head cover, is driven from the spindle through the feed change gears, then through a feed reversing unit to a feed distribution shaft. The rotation of the feed distribution shaft is controlled by a lever which operates a jaw tooth clutch. The lever also directs the rapid traverse to the same feed distribution shaft. The boring feed for the spindle passes from the distributing shaft through a pair of sliding gears to a worm shaft in the horn.


Hardened Nitralloy spindle; No. 5 Morse taper
Gear tooth clutch
Feed driving gear
Angular contact bearings
Hardened Nitralloy bushing
Two preloaded zero precision ball bearings
Shaved and lapped high-speed gear
Herringbone slow-speed gear
Zero precision ball bearing

Spindle is driven by two square keys set 180 deg. apart in the spindle sleeve. The rack for feeding is machined into the quill.

Rotary Head Feature of Vertical Milling Machine

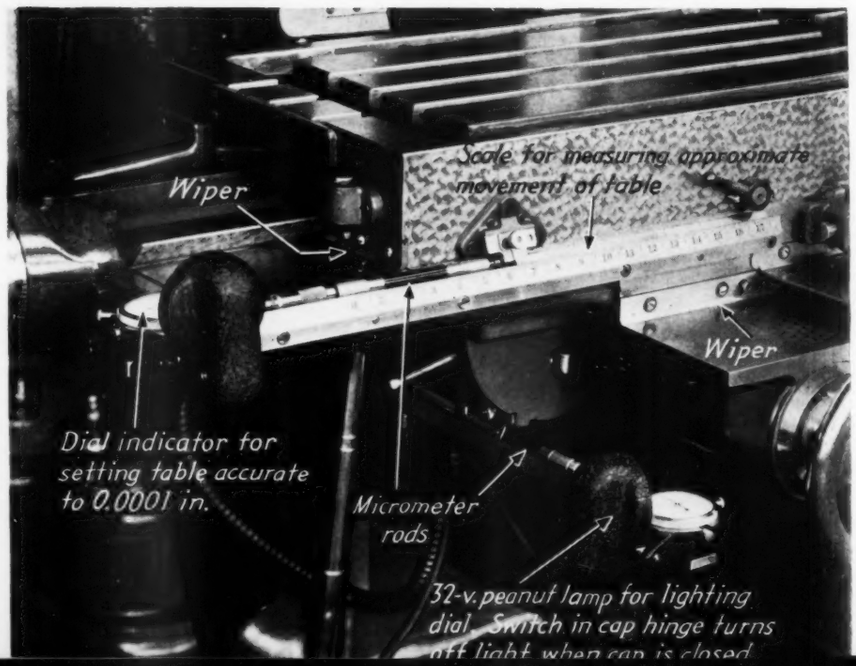


Planetary motion of the vertical spindle of the new rotary head tool and die milling machine of Kearney & Trecker Corporation involves noteworthy design features in the spindle mounting and drive. The machine is much the same as a standard milling machine in that it has column, knee, saddle, table and vertical spindle, but the spindle can be set off center in thousandths of an inch and rotated through 360 deg. at any one of 16 planetary speeds ranging from 1/5 to 3 r.p.m. with spindle speeds of 250 to 6,000 r.p.m. Primary advantage of design is to permit all layout work, milling, drilling, boring and slotting operations on dies to be completed with only one set up.

Structure. Main parts of machine are of cast iron. The knee is recessed into the column, bringing the center of gravity of the knee closer to column to provide greater strength, rigidity, and permanent accuracy. Column openings are in the sides centered on the neutral axis, leaving the back unbroken. Ways are integral with the casting and are scraped. Handwheels, dials and handles are chromium plated.

Master switch controls all current to machine motors which are individually operated by controls grouped on front of machine. All wiring is enclosed in flexible metal conduit inside machine frame. Outlets are provided in base for plugging in indicator dial lights, table power feed, air motor and coolant motor. This permits standardization of machine structure with facilities for extra equipment to meet user's requirements. Current for lights is stepped down to 32 volts for safety.

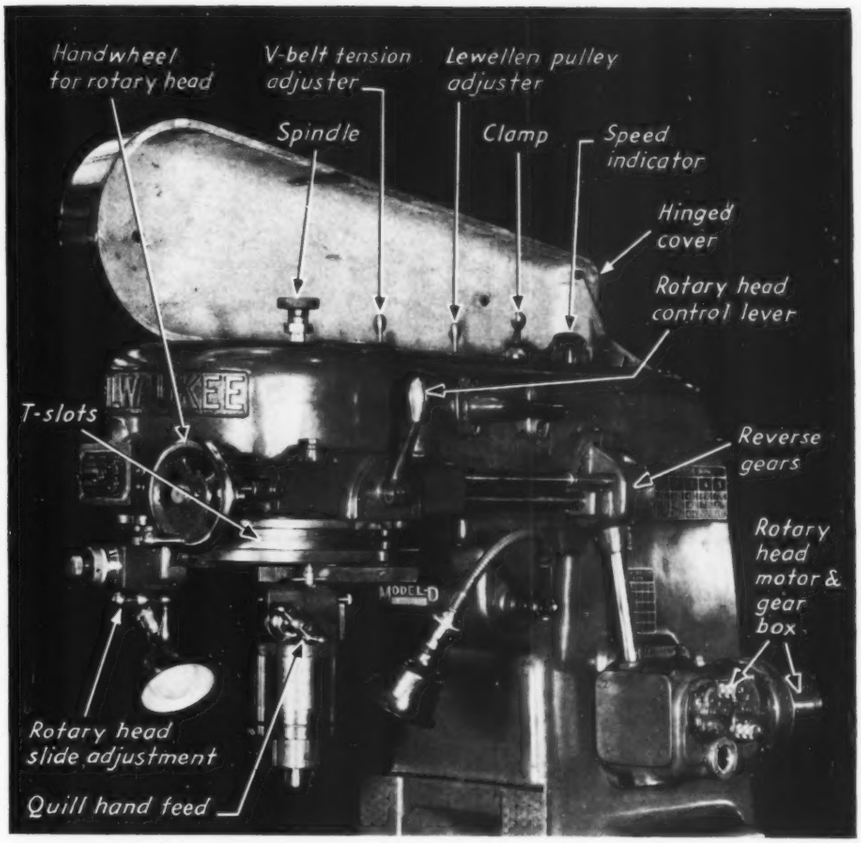
Dial indicator set, including micrometer rods, troughs and built-in dial indicators reading in 0.0001 in. is available where extreme accuracy is desired. Tolerances of 0.001 in. are obtainable directly from settings of large 5-in. micrometer dials. Machine accuracy, strength and sensitivity of operation is gained in table design by the combination of a comparatively small table supported by a saddle longer than table movements, and an extremely rigid knee. Accuracy of movement is provided through precision ground cross, longitudinal and vertical screws. Longitudinal and cross movement screws are equipped with adjustable nuts for elimination of backlash. All handwheels are clutched to remove possibility of accidentally disturbing table setup. Ways are kept clean by providing wipers as shown at right.

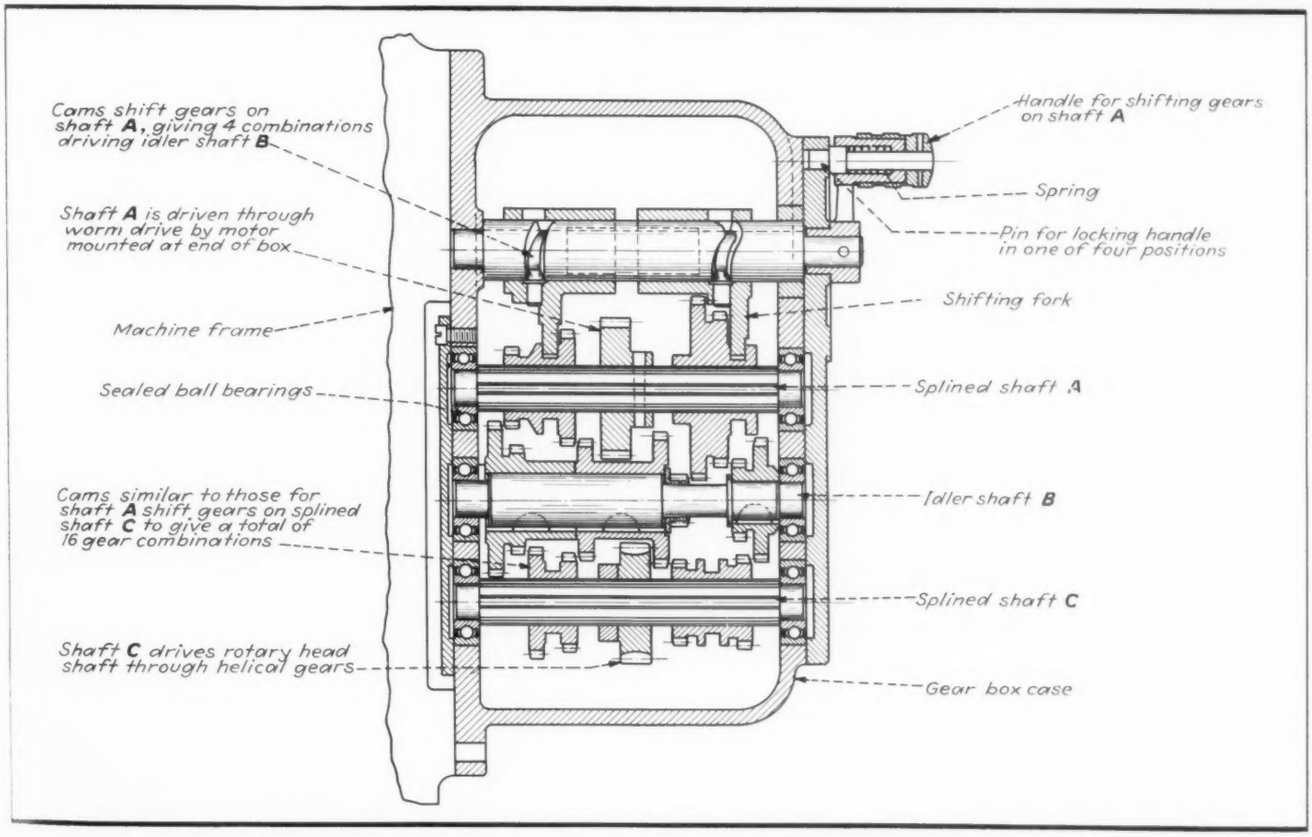

Wiper
Scale for measuring approximate movement of table
Wiper
Dial indicator for setting table accurate to 0.0001 in.
Micrometer rods
32-v. peanut lamp for lighting dial. Switch in cap hinge turns off light when cap is closed

Individual motors drive the rotary head and the spindle, permitting the spindle and the rotary head to be revolved independently of each other. Motor for rotary head, ¼ hp., is mounted at side of column, transmits power through gear change box, reversing gears and torque shaft to worm gear operating head. The periphery of the rotary head has T-slots in which trip dogs can be set, permitting automatic feed throwout at any point of the rotary travel. Head is graduated in degrees and its handwheel dial is graduated in minutes. Handwheel is removable, and index plates can be attached. Radially offset limits of spindle are from 0 to 4 inches.

Spindle motor is ½ hp., with adjustable V-belt drive giving a speed range from 250 to 6,000 r.p.m. Vertical power feed range of from 0.0002 to 0.006 in. per spindle revolution permits precision boring within 3-in. vertical movement.

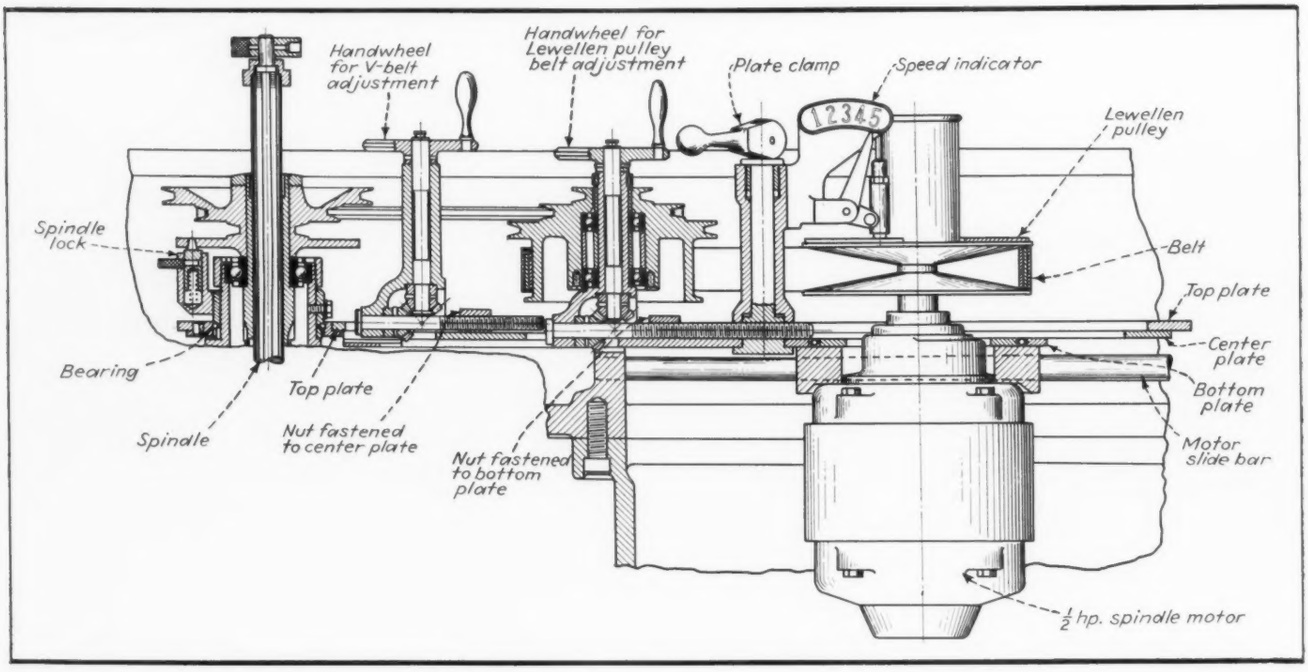
An entirely new milling machine attachment, known as the cherrying mechanism for the mechanical generation of cherrying type cuts, has been developed by Kearney & Trecker for use with this machine. It is mounted directly on the rotary head and ties together the cross slide motion with the vertical motion of the spindle, permitting circular movement of the cutter in a vertical plane.

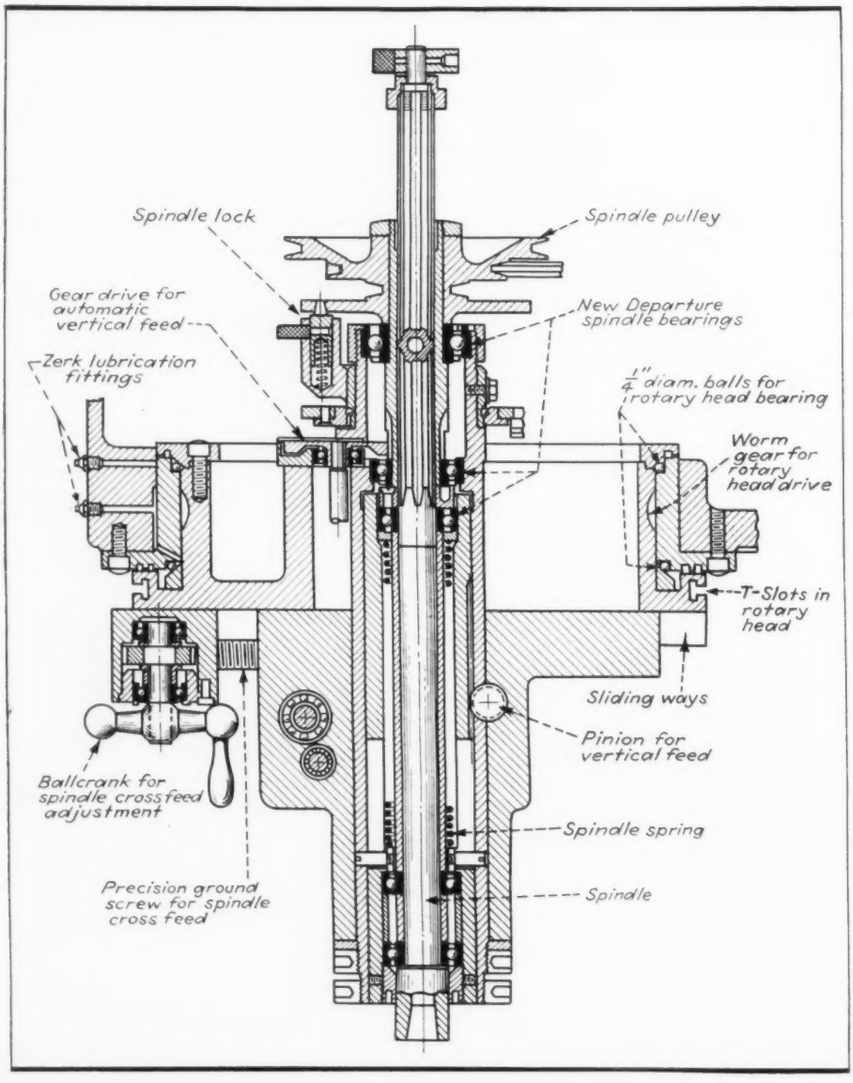



Cams shift gears on shaft A, giving 4 combinations driving idler shaft B
Shaft A is driven through worm drive by motor mounted at end of box
Machine frame
Sealed ball bearings
Cams similar to those for shaft A shift gears on splined shaft C to give a total of 16 gear combinations
Shaft C drives rotary head shaft through helical gears
Handle for shifting gears on shaft A
Spring
Pin for locking handle in one of four positions
Shifting fork
Splined shaft A
Idler shaft B
Splined shaft C
Gear box case

Compact gear box for rotary head drive, mounted on side of column, provides 16 speeds. Motor mounted on end of gear box drives shaft A through worm gear. Cam, operated by handle outside of box, shifts paired gears on shaft A, to one of four combinations. Power is transmitted to idler gears on shaft B. Paired gears on shaft C, shifted by cam similar to that for shaft A, transmit motion from idler gears to shaft C, which drives rotary head shaft through helical gears. A similar type of gear box is used between the table drive motor and the feed screw. ***(Continued on next page)***

Rotary Head Feature of Vertical Milling Machine *(Continued)*

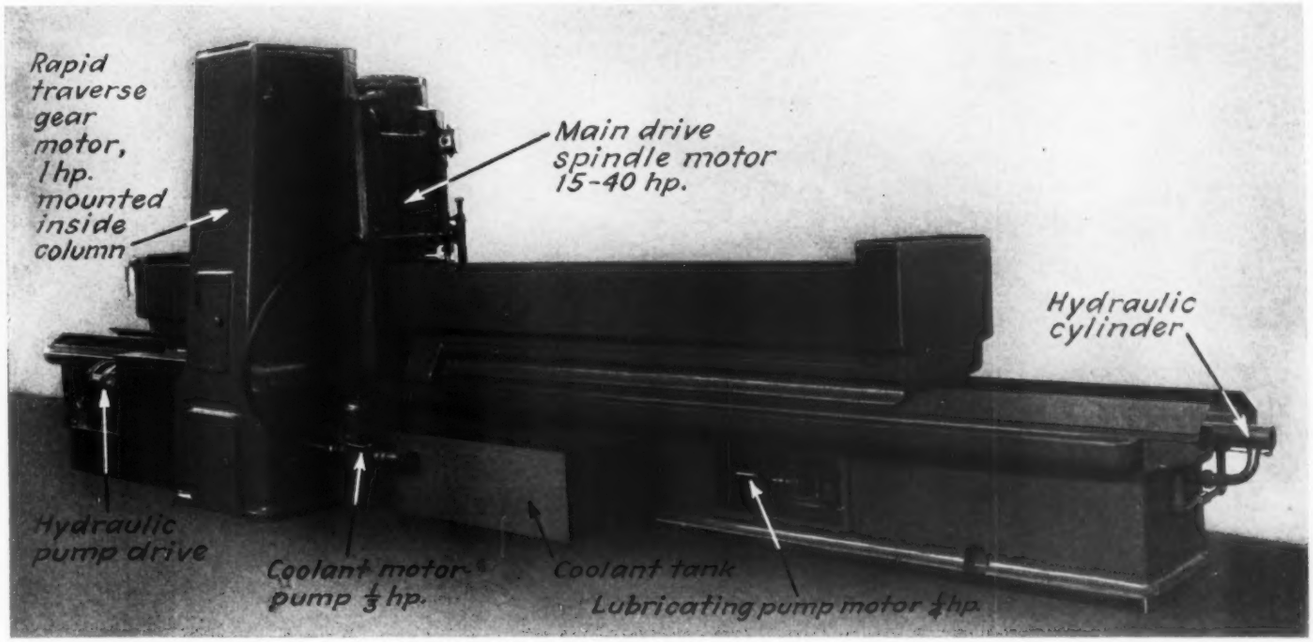




Spindle drive is mounted on a device similar to a locomotive cross-head slide to accommodate the combined spindle rotation and the eccentric motion of the rotary head. Motor slides forward and backward on two parallel rods held in the drive housing. Three sliding plates hold motor, idler pulley and spindle in proper relation to each other and also permit speed adjustment as shown in the diagram. Lewellen pulley adjustment is made by handwheel through bevel gears to a screw which changes position of bottom and middle plates. V-belt adjustment is made by handwheel which changes relation of middle and top slide plates. After belt adjustments are made, slide plates are locked in place by clamp. Rotary motion between the spindle head and slide plates and between the motor and slide plates is taken care of by ball bearings.

Rotary head travels on a pre-loaded double ball-bearing almost 14 in. in diameter with balls ¼ in. in diameter. The inner race of this large bearing acts as a support for the spindle. Spindle is moved by a precision ground screw in a slot in the casting which forms part of the inner race. Bearings are lubricated through Zerk fittings. Rotary head acts as worm wheel, and is driven by a worm on the torque shaft which is connected to the change gear box and to the manual hand wheel. The spindle is mounted in the rotary head assembly on sealed-for-life New Departure super-precision matched bearings, and is equipped with a lock. Spindle quill gives 3 in. of vertical motion, power or hand operated.

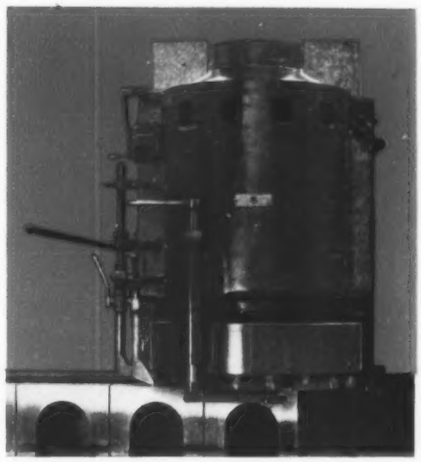
Vertical Grinder with Hydraulic Table Drive

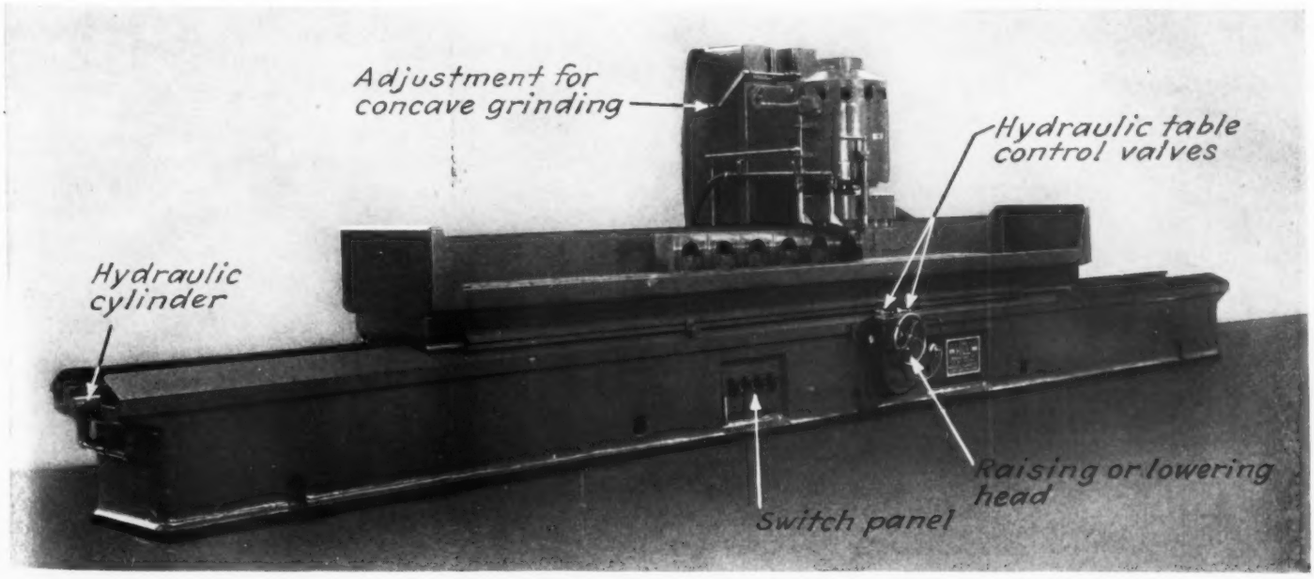

Rapid traverse gear motor, 1 hp. mounted inside column
Main drive spindle motor 15-40 hp.
Hydraulic cylinder
Hydraulic pump drive
Coolant motor-pump ⅓ hp.
Coolant tank
Lubricating pump motor ¼ hp.

Heavy-ribbed alloy iron castings and anti-friction spindle mountings minimize vibration and make possible heavy cuts without loss of accuracy in the Hill Clutch Machine & Foundry precision surface grinder. Bed, table and columns are cast of nickel-chromium iron, with 10–20 per cent Mayari pig and 30–50 per cent steel used in the mix. For other parts, mix has nickel content of 1.25 per cent, 0.50 per cent chromium, 3.00 per cent total carbon and 1.70 per cent silicon. Alloys add wear resistance, improve machinability and give a fine-grained uniform structure with smooth surface finish. Higher modulus of the nickel-iron improves rigidity and thus accuracy in machining.

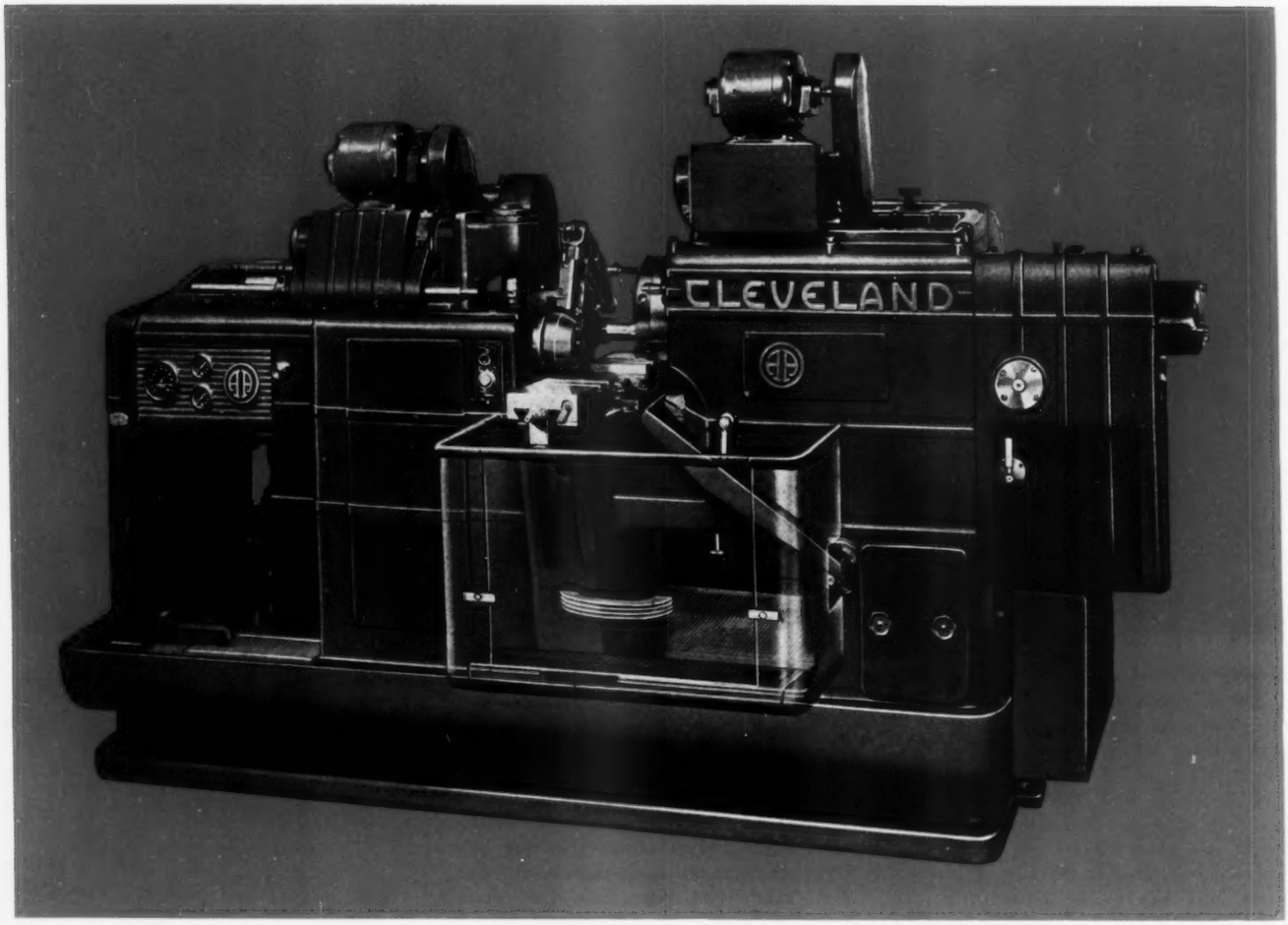
Hydraulic circuit employs two main cylinders to actuate table. A feed valve operates in conjunction with a four-way, pilot-operated valve, controlled by reversing lever, that alternately supplies pressure to one cylinder while the other is open to drain. A relief valve maintains back pressure from emptying cylinder and steadies table movement. See *P.E.* June 1939, page 236, for circuit diagram.

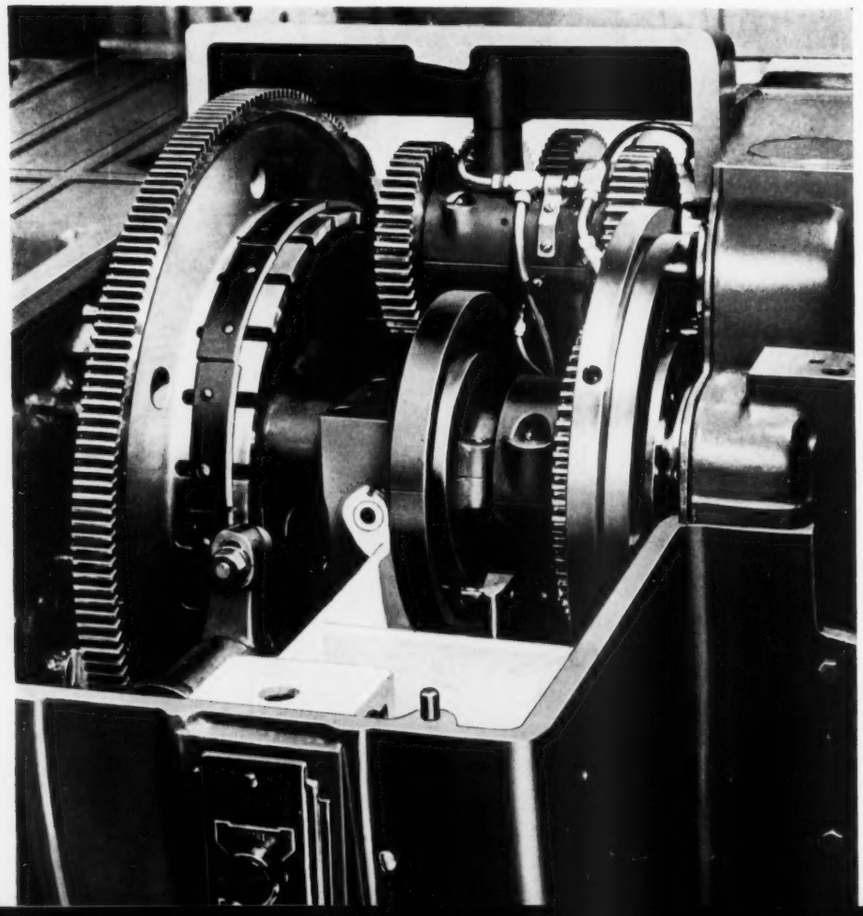
Wheel spindle is of hardened, ground and lapped alloy steel supported in two Timken roller bearings, grease lubricated. Head is raised and lowered by a 1 hp. ball bearing gearmotor operating at 194 r.p.m. through a Twin-Disc clutch.





Single Spindle Automatic Screw Machine

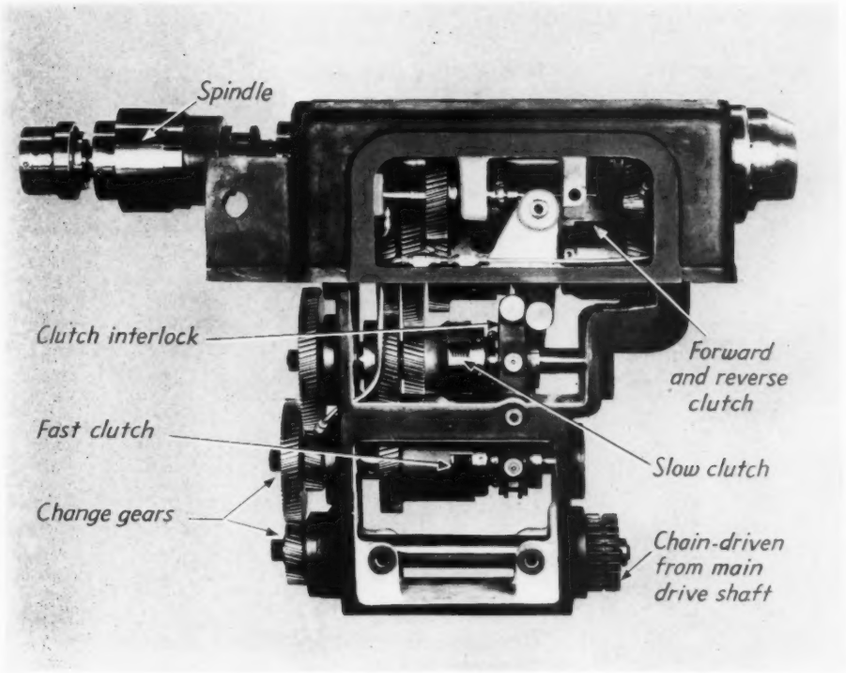




Cam-operated throughout. the Cleveland Automatic Model AA is adapted to receive any regular attachment without change in the machine proper. The specially-designed attachments are easily mounted by merely removing and replacing four hollow-head screws.

Power is supplied by a 7½ hp. motor which drives through a Dayton cogbelt to a drive shaft which drives spindle head. lubricating units and the single camshaft that times all machine and attachment operations. Bed. spindle head and other large castings are poured from a closely controlled gray iron. Tool-turret is a Mechanite casting. Anti-friction bearings are used.

Variable feed is obtained with a Briggs and Stratton transmission controlled through a bell-crank mechanism actuated by a roller riding on an adjustable circular cam. Feeds can be "tuned-up" while the job is in production; this is not possible when the operator is committed to feed obtainable by an existing special cam. Entire feed mechanism is inclosed. Tool turret is supported on a large bearing surrounding the turret bored and scraped in the turret support.



Spindle head is a fully-inclosed, all-geared unit contained in a single gray iron casting mounted rigidly in the bed. Spindle head shafts are chrome-moly steel, S.A.E. 4140; spindle head gears are S.A.E. 4150, hobbed and shaved, and heat-treated to 331 Brinell. Roll pins are S.A.E. 3250 chrome-nickel steel; cam rolls are S.A.E. 32100. Lightly loaded feed gears are S.A.E. X-1315, heat-treated before machining to eliminate distortion. Spindles are forged from medium-carbon, high-manganese steel, S.A.E. X-1335, annealed, normalized and heat-treated in the rough to eliminate distortion. ***(Continued on next page)***

LUBRICATION CHART

Bijur pump unit, fitted with mercury float switch in reservoir, supplies:

(a) Constant feed to main spindle bearings. Fresh oil only is fed to these bearings; oil outlet is vented to spindle head gear case.

(b) Periodic metered lubrication to all bronze bearings.

Oil pressures are indicated by two small gages on instrument panel.

Tuthill pump, fitted with pressure switch which cuts out all motors on oil pressure drop, supplies:

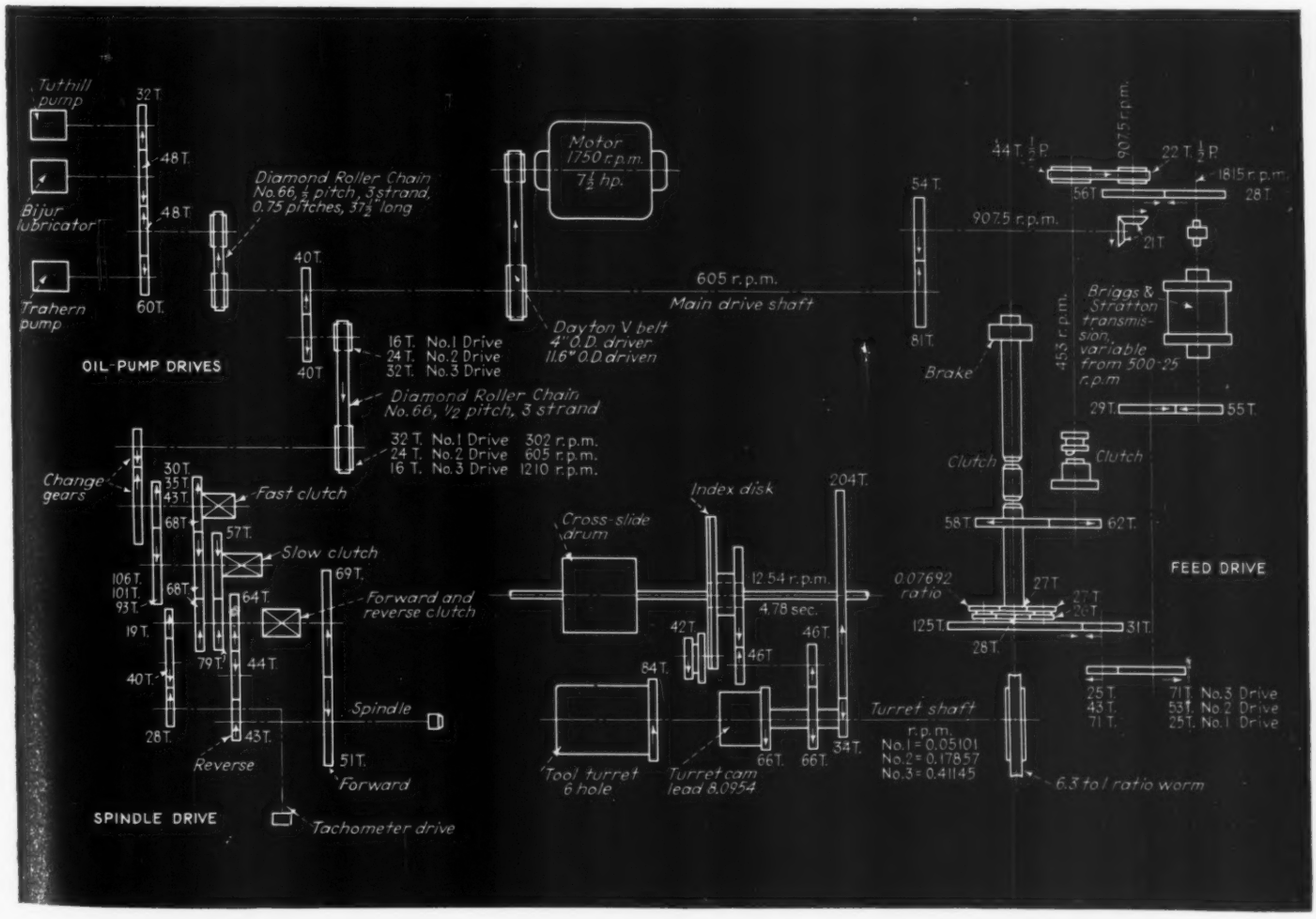
(c) High pressure lubrication to spindle head gears. High pressure jets of oil are directed into the gear meshes; balance of spindle head is lubricated by the spray created by gear action. Pressure is indicated by a large gage on the instrument panel.

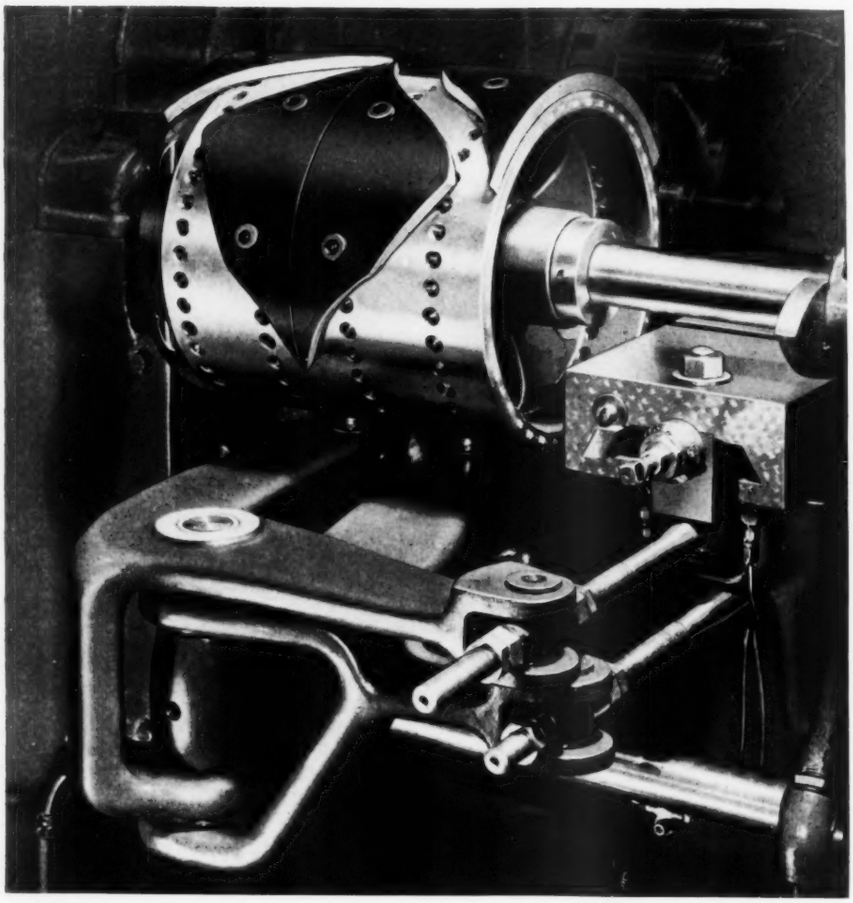
(d) Remainder of mechanism is lubricated by a low pressure system which receives its supply from the overflow of the high pressure system (c).

All oil used in systems (c) and (d) is recirculated and filtered through a Cuno filter before passing to the pump.

Trahern pump supplies oil which also passes through a Cuno filter.

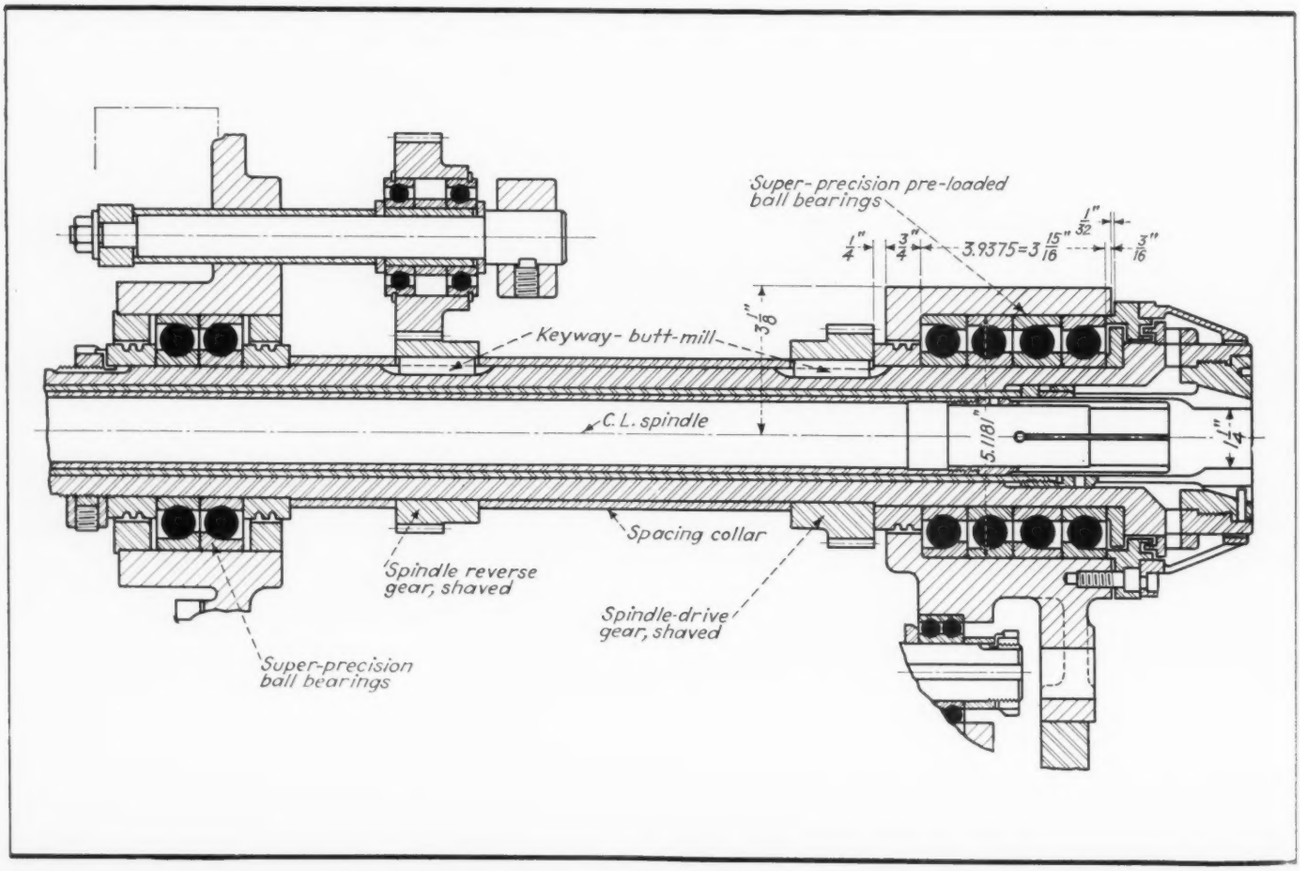
Lubricating pumps and filters are grouped in a sub-assembly located in the right hand base of the machine.



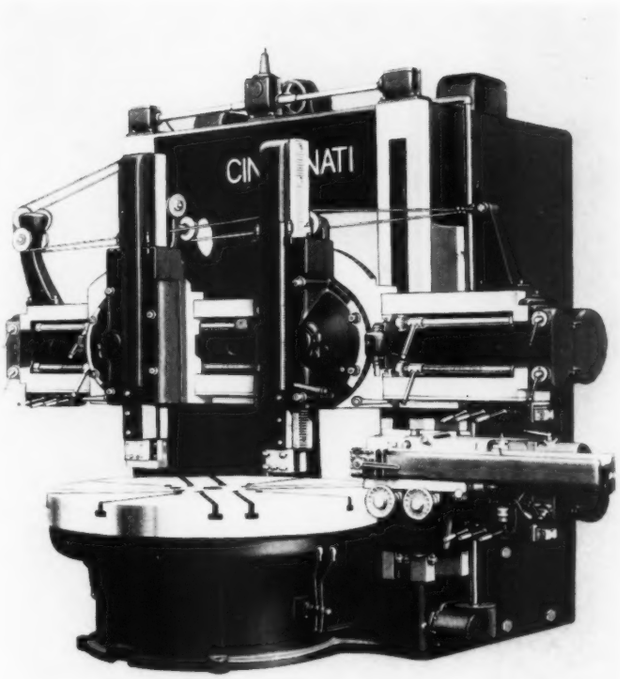


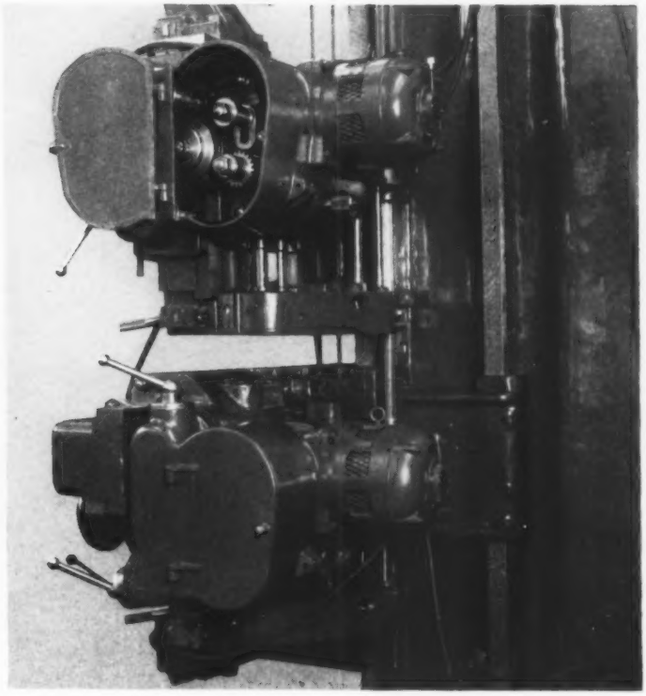
Universal camming operates all tools, cross slides, stock feed and chucking mechanism. Cams are mounted on drums which have a series of tapped holes in their periphery, permitting relocation when necessary and eliminating the need for special cams. Improvements in cross-slide construction include single-screw adjustment of gibs, inverted dovetail construction of the rear slide, dial setting for quick adjustment to tolerance of formed work and Neoprene wipers.

New preloading method, designed to increase spindle rigidity and to insure cool, chatter-free operation over the entire speed range of 203 to 3,275 r.p.m., was developed in cooperation with Fafnir Bearing engineers. Two matched pairs of super-precision ball bearings are used at the spindle nose. Thus preload is applied to two pairs of bearings instead of the conventional single pair. This type of bearing assembly is rigid, can be preloaded accurately, and requires no adjustment over the entire speed range.



Boring Mill Has Integral Bed and Gear Box

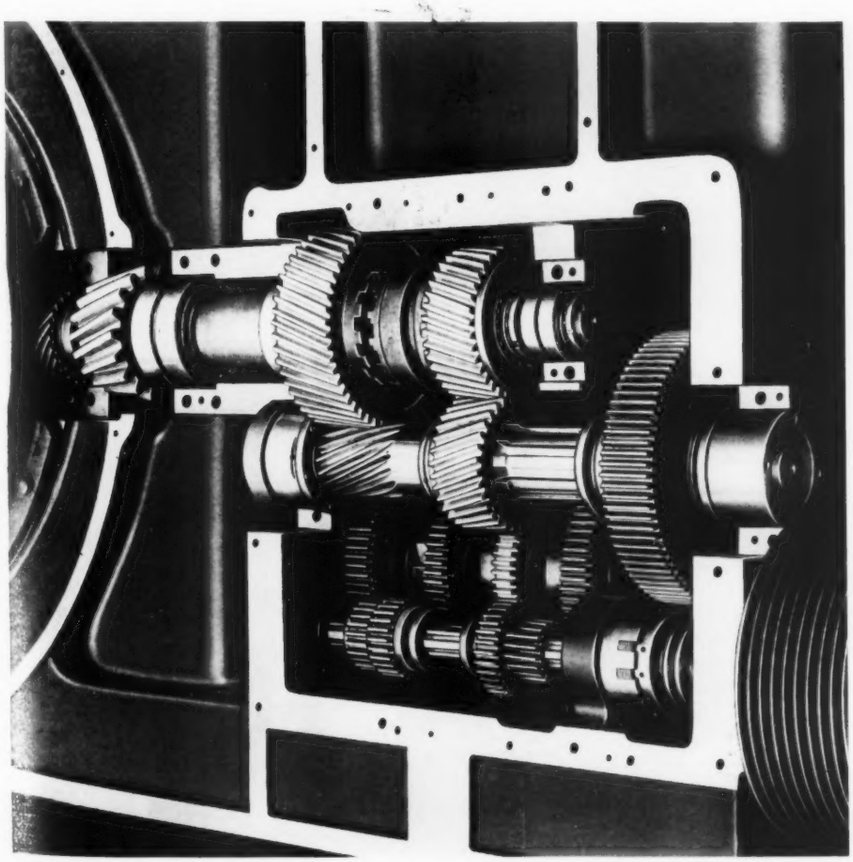




Pyramid type housings with broad faces and long bases assure rigidity under severe duty in Cincinnati Planer Company's vertical boring mill. Counterweights are suspended inside housings.

Cross rail is of the box form and is provided with a long narrow guide bearing on the bottom to maintain alignment and to prevent tilting and binding of the head. Rail is mechanically clamped to the housings and can be operated manually at either end of the rail.

Rapid traverse motors are mounted separately on the cross rail and on the side head. Safety clutch for feed and rapid traverse is shown in end view of cross rail with box open. Rams are made in a box section from Meehanite iron.

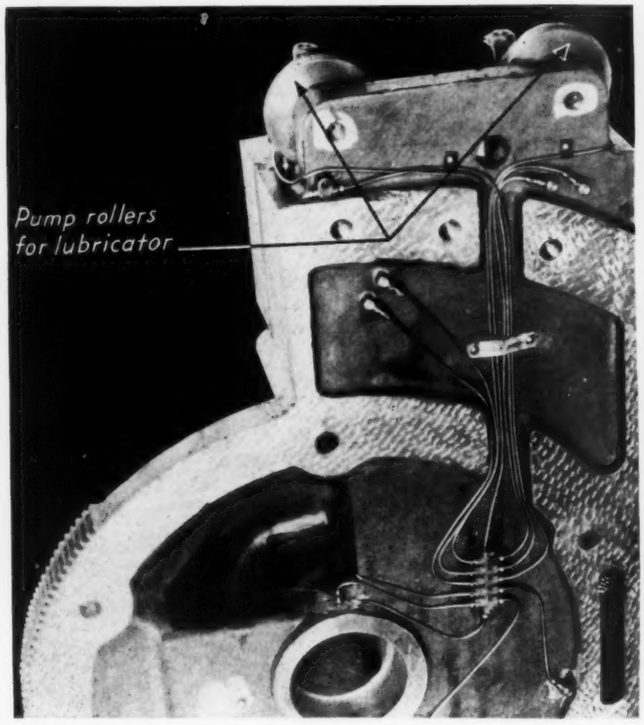


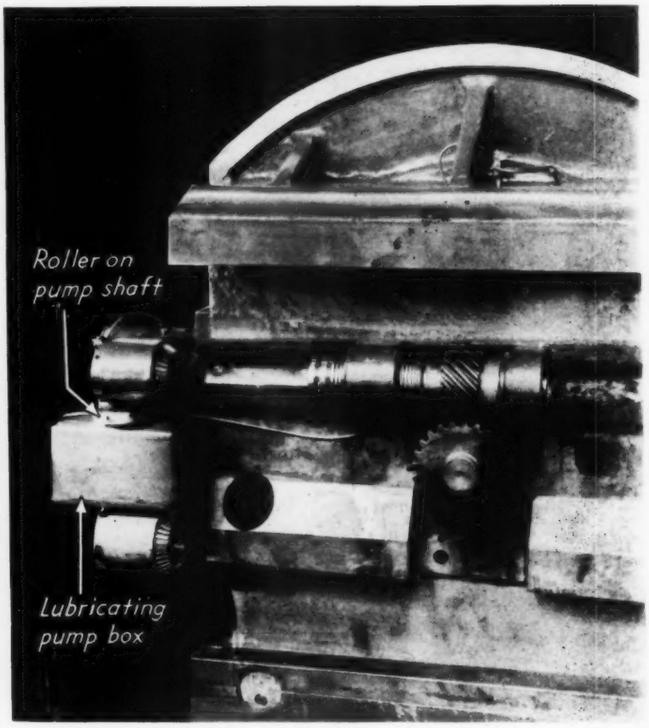
Bed and speed box are of one-piece construction. The semi-steel conical track which forms the table bearing is renewable. All gears in the transmission are made from heat-treated alloy steel forgings. Pinions are made of hardened steel. Heat-treated alloy steel sliding spur gears on multiple splined shafts are used for the first changes, helical gears are used for the final drive. The drive is Timken mounted throughout with four sets of double row bearings on the main drive shaft, the intermediate and other shafts are mounted and supported with two or more sets of bearings.

Constant speed a.c. motor drives gear box through a V-belt drive. Gear box provides 16 speeds to table. With constant speed a.c. motor drive the table is started and stopped through a multi-disk clutch and brake arrangement. If variable speed d.c. motor is desired, drive is through a gear train having four mechanical speed changes. The table is started, and stopped by dynamic braking applied to the main motor through pushbutton control.

Complete main drive, table and spindle are automatically lubricated with oil pumped from a reservoir in the base through a filter, the lubricant is then distributed to bearings and other working parts. ***(Continued on next page)***

Boring Mill Has Integral Bed and Gear Box *(Continued)*





Pump box with pistons actuated by rollers is mounted on back of cross rail saddle and is used for lubrication. Pump arm is operated by means of roller which runs over protruding pins mounted in the rail of the boring mill. Same type of lubrication system is used on the rams. during the travel of the ram similar rollers bump over protruding pins mounted in the swivel to operate pistons in pumps which lubricate the swivel mechanism. The back view of the rail head swivel shows how the lubricant is carried from the main pump and distributed by means of piping to the different bearings.

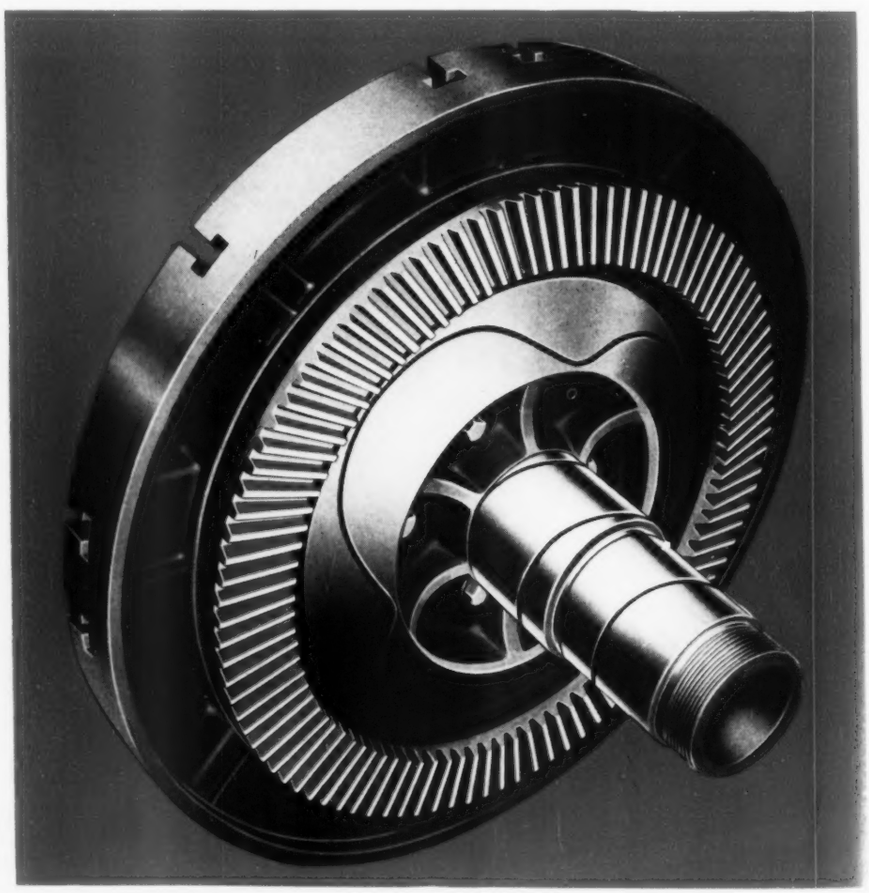
Table is reinforced by heavy radial ribs and is provided with parallel and radial tee slots. Dimensions of the parallel tee slots comply with standard specifications of face plate jaws. The table is driven by a wide face steel table gear which is nearly the full diameter of the table, thus obtaining maximum torque for machining large work. The spiral bevel pinion has double Timken bearings on both sides to reduce strain on the pinion shaft.

Drive gear on table is flame hardened. this gear is driven by an alloy steel heat-treated bevel pinion having spiral teeth of special design to obtain true tooth contact and a smooth drive.

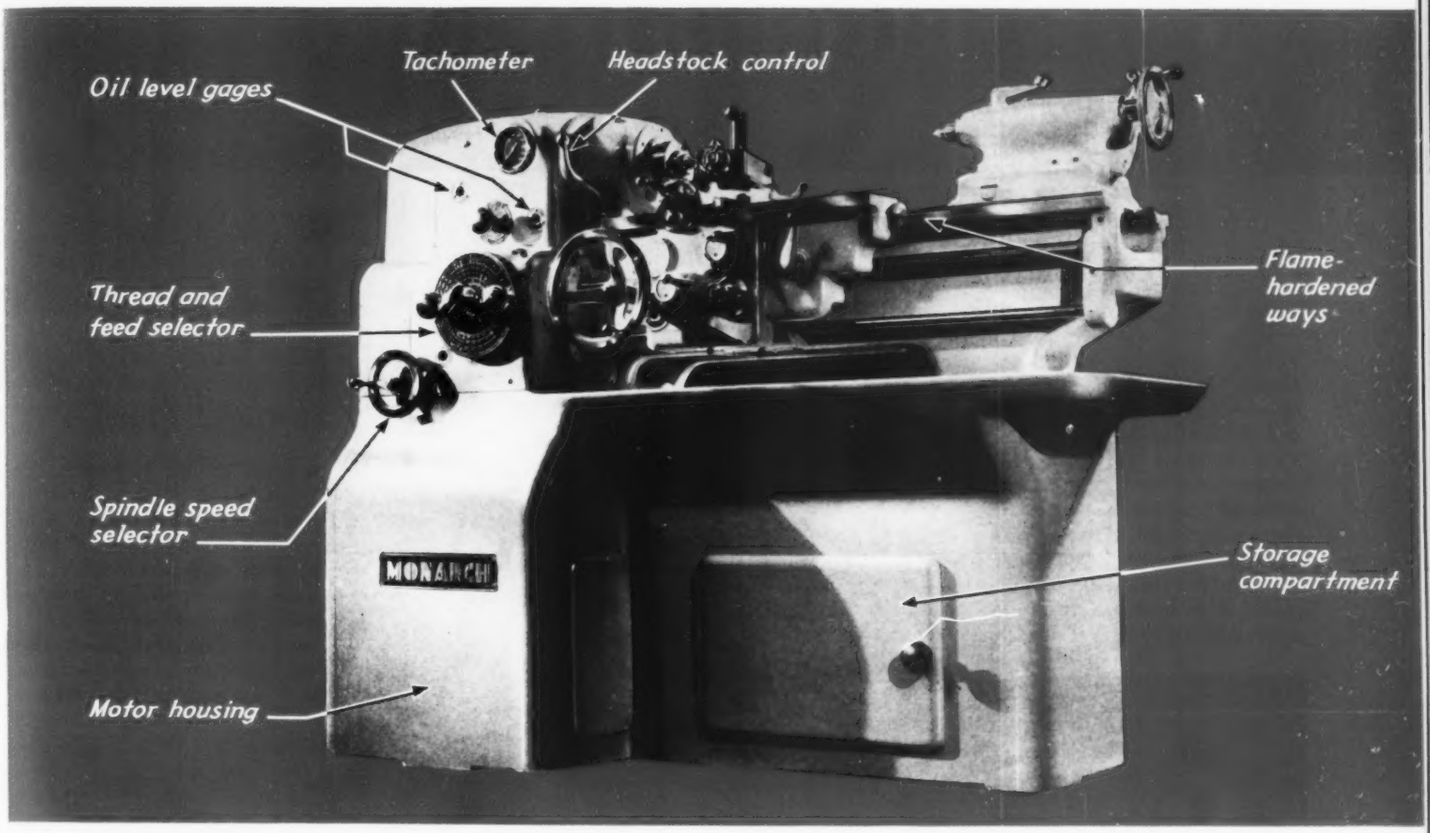
To reduce the tendency to spring the bed or table, the bearing for the table is placed under the normal position of the load. The renewable conical track which supports the table is bolted and doweled to the bed.

Positive pressure lubrication is provided for table track, transmission gears and bearings. The main drive motor is interlocked through an oil pressure switch with oil pump motor, so that it is impossible to run the table without the specified lubricant pressure.

Individual motors are used for main drive, elevating mechanism, for traversing rails and side heads, lubricating and coolant pumps. Motors are idle except when operating their respective units.

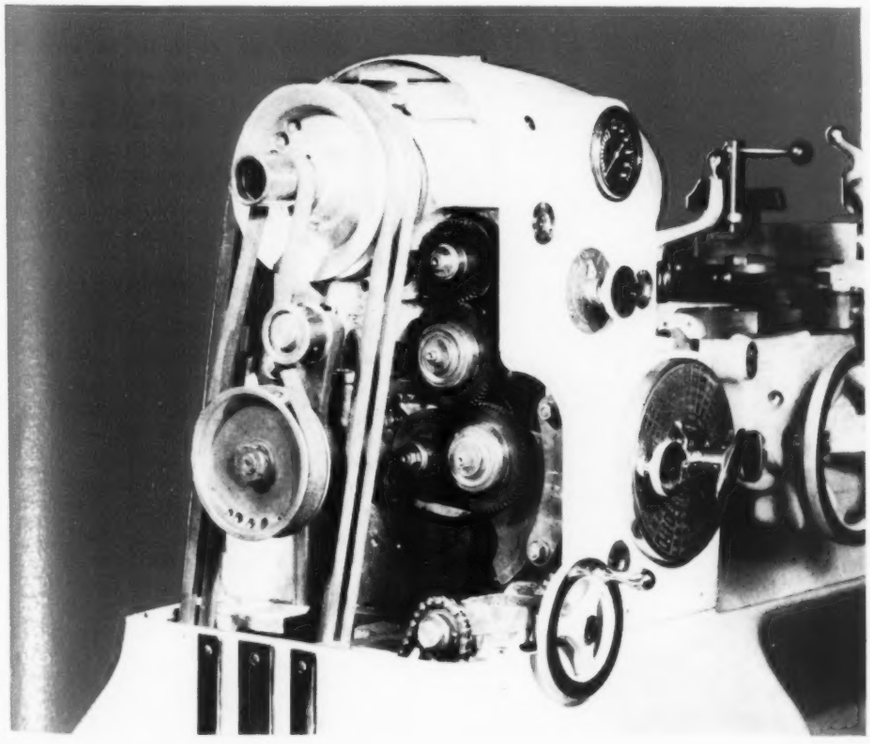


Built-In Motors and Controls in Streamlined Lathe



Main drive in the Monarch Machine Tool Company's 10-in. precision lathe is through a hydraulic variable speed power unit which provides a spindle speed range of 100 to 1. Speeds up to 5,000 r.p.m. are available. Power is transmitted from the main drive by two V-belts directly to an aluminum pulley mounted on the end of the spindle. All gearing is hardened nickel-alloy steel with tooth contours ground to tolerances of 0.0002 inch; all the rotating parts in machine are mounted on anti-friction bearings.

Bed, headstock, tail stock, carriage, apron, gear box, and taper attachment are Meehanite castings. The bed is of high-strength Meehanite, ways are flame hardened and ground, which makes possible the use of anti-friction bearing carriage gibs. The gibs remove tendency of carriage to lift or to climb from the bed way surfaces. Five oil-sealed, self-aligning, ball bearing gibs are used.

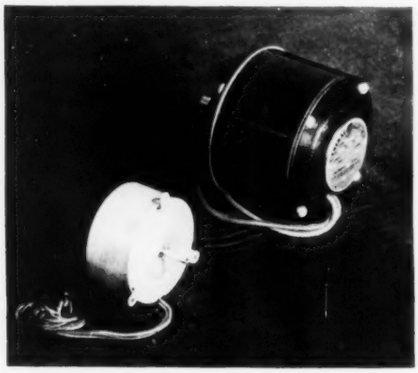


Motor-driven coolant pump is inclosed in a special compartment, shown here with cover plate removed. Cored slots covered by chromium plated strips, instead of conventional louvres, provide ventilation. Control compartment in the rear of the machine contains forward and reverse magnetic starting equipment, and overload and low voltage relays. Alongside is a drum-type selector switch which controls ¼ hp. coolant pump motor.

New Materials and Parts

Synchronous Inductor Motors

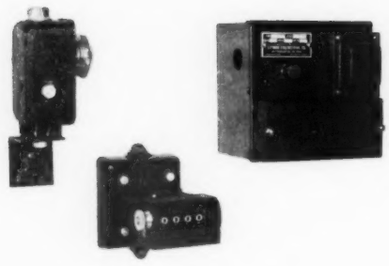
A new line of a.c. fractional horsepower motors are for use on indicating and recording instruments, small regulating or control devices, remote control devices, and similar applications. They are essentially inductor alternators operated as motors with an Alnico permanent magnetic field replacing the usual d.c. field. Motors are built in two frame sizes. In the larger frame size two motors, one delivering 40 oz. in. torque at 75 r.p.m., and the other delivering 75 oz. in. at 75 r.p.m. are available. In the smaller frame sizes,



four motors are available; a 100 r.p.m. motor which delivers 2 oz. in. of torque and three motors with built-in gear reduction. The latter are offered in the following torques and speeds: 48 oz. in. at 1 r.p.m.; 24 oz. in. at 2 r.p.m.; and 12 oz. in. at 4 r.p.m. All of these motors are of permanent split-capacitor type with separately mounted Pyranol capacitors. General Electric Co., Schenectady, N. Y.

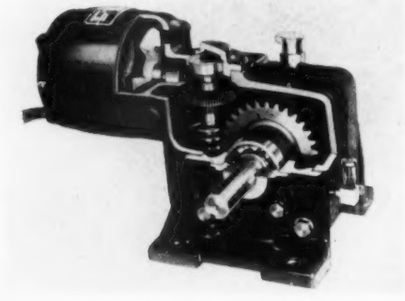
Photoelectric Counting Equipment

Photoelectric amplifier contact relay unit, terminal board, power transformer for amplifier, and light source are all mounted as integral parts of the new Model 566 photo electric amplifier unit. The unit uses one tube of standard type, having within it both rectifier and amplifier elements. In order to minimize the effects from stray lights, the photo cell is mounted 4 in. from the opening. Operation is d.c., allowing maximum sensitivity and ease of maintaining adjustment. Unit will operate on visible or invisible light. Control relay is plug-in type and can be removed the same as the tube for inspection or replacement. A pair of contacts is provided which are closed when light shines on cell. When the light is cut off from cell, these contacts open and an additional pair of contacts close. Contacts will make or break and carry 3 amp. at 110 volts a.c. Estimated tube life 7,000 to 10,000 hrs. Tested for speed of counts up to 600 per min. and supplied complete with four-digit counter and light source. Lipman Engineering Co., 415 Van Braam St., Pittsburgh, Pa.



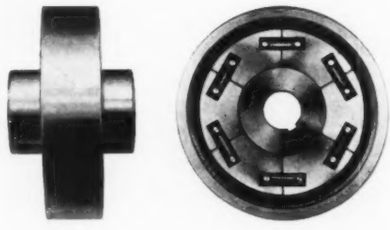
Motor-Speed Reducer

Designed primarily for very low speeds and high torques, this new unit is sturdy, compact, and provides a combination of speeds and torques not heretofore available. The motor itself develops from 1/50 to 1/20 hp., depending upon the gear ratio used. Worms are accurately ground from hardened steel. Primary gear is of bakelite to provide quiet operation. Ball bearings are used throughout, and intermediate shaft bearings take end thrust in either direction so that unit is reversible. Available with reduction ratios ranging from 72:1 to 2,880:1, speeds as low as 0.6 r.p.m. and torques up to 350 in.-lb. Almost any specified mounting position can be obtained. Bodine Electric Co., 226 W. Ohio St., Chicago, Ill.



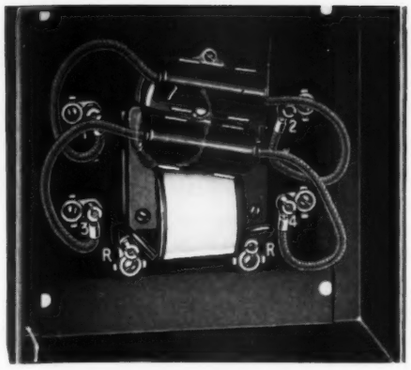
Centrifugal Clutches

New, positive acting, automatic centrifugal clutch for all types of industrial power drives is simple but rugged in design. The clutch consists of two parts, the housing drum or driven member, and the expansion body or driving member. A steel cover-plate held in position by means of a lock ring seals mechanism against dust. There are no metal to metal wearing surfaces, and no lubrication is required. It can be built to engage smoothly at any desired speed and for any horsepower. Six standard sizes range from 1 in. up to $2\frac{3}{8}$ in. shaft diameters for between 0 and 125 hp. Dawes Equipment, Inc., 2280 Penobscot Bldg., Detroit, Mich.



Autocall Relay

New M-39 relay, designed for high speed operations, is rotating type, employing a tilting mercury switch. A magnetic brake dampens the movement of the switch. The mercury switch, attached to a rotating disk on the armature shaft of the magnetic element, is unbreakable and eliminates the annoyance of broken tubes common with glass-inclosed switches of former design. The switch consists of an iron tube, insulated cap and refractory breaker. This breaker shields the metal parts from the arc and retains a pool of mercury in the cap end of the switch so that there is always a positive mercury-to-mercury contact



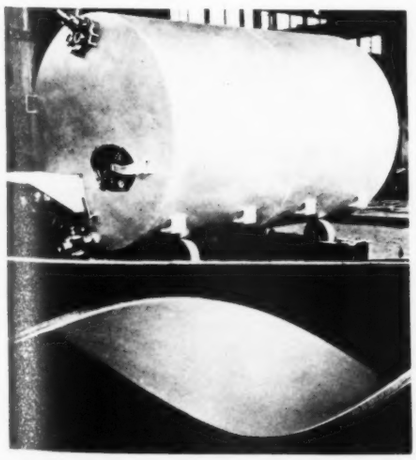
The M-39 relay is furnished in two styles, one with a single mercury switch and the other with two switches. The switches are furnished for make or break, or for make-break combinations. Breaking capacity is 15 amp. at 115 volts a.c. Autocall Co., 26 Mack Ave., Shelby, Ohio.

Microweave Tracing Cloth Packed in Box

"Microweave" is a new tracing cloth of fine, even weave, with 180 flawless threads per inch. This fine weave gives good transparency, provides maximum strength with minimum bulk, and accepts the finest drawn detail readily and, having no flaws or weak spots, endures repeated erasure. Each roll of the cloth is packed in a dust proof dispenser box which keeps the material fresh, smooth and clean until needed. Box may be fastened to wall or to side of desk with brackets. Holliston Mills, Inc., Norwood, Mass.

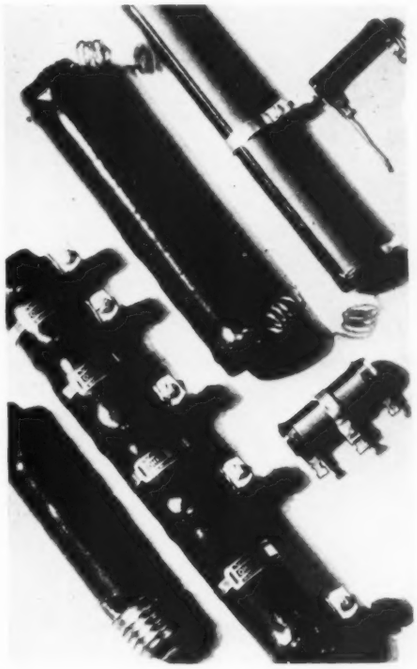
Stainless Clad Steel

Stainless clad steel sheets and plates, known as Silver-Ply, combine the corrosion resistance of stainless steel with many of the desirable properties of mild steel. Silver-Ply may be bent, spun into deep heads, deep drawn, drilled and otherwise worked with greater ease than solid stainless, and has better heat conductivity than solid stainless. Manufacturing process assures a strong uniform oxide-free weld between the stainless cladding and the mild steel backing. Usual sheet consists of 20 per cent stainless steel and the balance mild steel. All degrees of cladding from 3 to 50 per cent have been successfully produced. Jessop Steel Co., 573 Green St., Washington, Pa.



Resistors

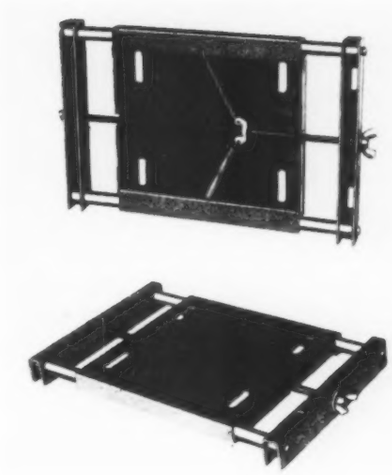
A new vitreous enameled wire wound resistor is known as Vitrohm. Ten years of intensive research on refractories, wire



processing and enamel has produced a crazeless enamel structure that withstands humidity, moisture, immersion and numerous other specified tests. Ward Leonard Electric Co., Mount Vernon, N. Y.

Motor Base

New low-cost motor base, called the "Automatic," automatically maintains correct belt tension through the action of special high grade steel springs, making it especially suited to short center drives. Covers all types of drives, horizontal, vertical, or overhead, and operates satisfactorily with any type of load. To take up slack in belts from normal wear and



stretch, it is only necessary to give the adjusting screw a few turns. Spring tension holds the motor, takes up slack, and cushions load shock that might otherwise damage motor and bearings. Constructed throughout of steel, it is easily installed. Ideal Commutator Dresser Co., 1446 Park Ave., Sycamore, Ill.

Rectifier

In this new electronic tube rectifier, six inexpensive tubes are used to full wave rectify all three phases of a 220 volt a.c. line, resulting in an output d.c. voltage having very little ripple. The voltage remains practically constant regardless of the load, because of the inherently good voltage regulation of the mercury vapor tubes. Low internal voltage drop in these tubes provides high efficiency. There are no moving parts to wear out or require maintenance. Tubes have a guaranteed life of 2,000 hours under full load. Rectifier, which can be installed by connecting three a.c. wires, and two d.c. wires, meas-

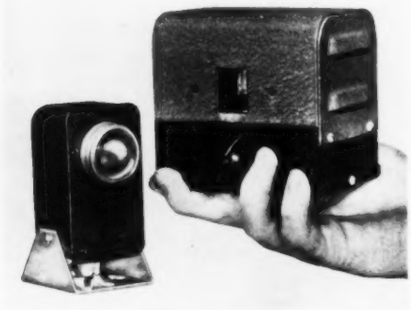
ures 13 x 18½ x 24 in. and weighs 210 lb. Provision can be made for dynamic breaking when required. Mellaphone Corp., Rochester, N. Y.

Neoprene Belting

This all-Neoprene friction surface transmission belt will withstand the destructive action of mineral oils. Known as the Duroil Howprene transmission belt. There is no natural rubber in this belt, the friction and skim compounds being of Neoprene synthetic oilproof material. The Neoprene friction and skim coat protect the cotton duck against wear, ply separation, and softening from oil at high temperature. By virtue of their oilproof quality, Howprene transmission belts are claimed to require less take-up and maintenance supervision than rubber belts. Hewitt Rubber Corp., Buffalo, N. Y.

Photoelectric Control

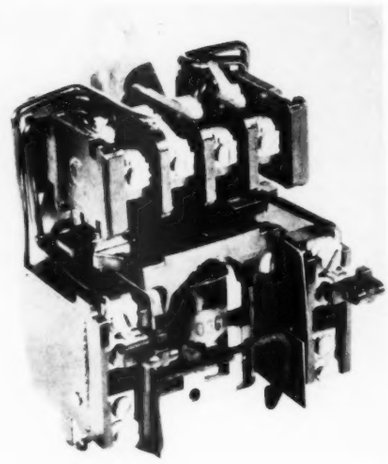
Photoelectric control device, consisting of light source and control box complete with plug-in wire connections, operates on 110 volts, 60 cycle a.c. Current supply to light source is from 6-volt transformer



in control. Power relay is designed for 3 amp., non-inductive loads. Potentiometer adjustment permits compensation for various degrees of light intensity to photo-cell. Standard 6J5 tube will last 3,500 hours. United Cinephone Corp., 43–47 Rawson St., Long Island City, N. Y.

Magnetic Switches

New Size O magnetic switch, for use with single-phase motors up to 1 hp., 110 volts, and 1½ hp., 220 volts, or polyphase motors up to 1½ hp. 110 volts, and 2 hp. 220–600 volts, is made in 2-, 3-, and 4-pole forms. Switch is available in general purpose, dust-tight, and water-tight cases. The magnet of the new switch is of the E-type with three sealing surfaces to decrease the hammer blow



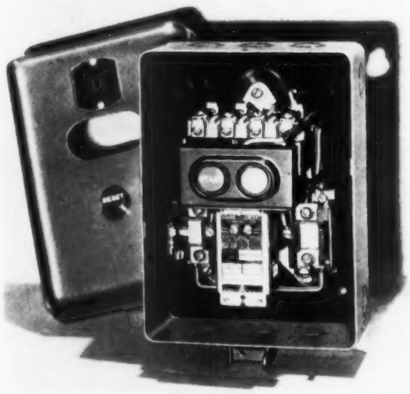
in closing and to increase the life of the magnet. Contacts are double-break, made of fine silver, and are easily removed for inspection or replacement. General Electric Co., Schenectady, N. Y.

Illium

The corrosion resistant alloy, Illium, is manufactured in two compositions: Illium G alloy, used in ordinary castings, centrifugal castings, cast bar stock and larger hardware; and Illium R alloy which is used for strip welded tubing and rolled rods. Both forms of the alloy are non-magnetic. The material is particularly designed for application where unusual corrosion resistance, high strength, machinability, and the ability to resist erosion are required. It is now available in castings, strips, hardware, centrifugal tubes, welded tubes, cast bars, rolled rods, welding rod and wire forms. Burgess-Parr Co., Freeport, Ill.

Automatic Starter

New Size O, Type R, Class 8536 automatic starter for the smaller sizes of polyphase and single phase motors supplements the present line of Square D verti-



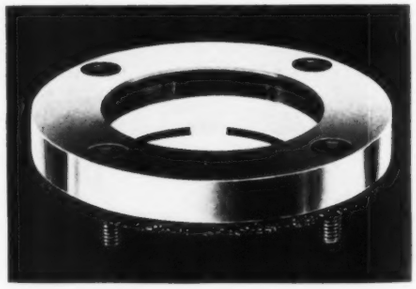
cally operating automatic starters. It has a vertically operating magnet, double break silver contacts and thermal overload relays. Offered with general purpose, dust-tight, water-tight or Class 2, Group G inclosures; also as a combination starter with either disconnect switch or circuit breaker. Square D Co., 710 South Third St., Milwaukee, Wis.

Synthetic Enamel

A new line of high speed synthetic enamels are especially suitable for use on metal products subjected to severe service. These enamels, known as "Codur" enamels, bake in a few minutes to a fine finish that is durable and resistant to marring, moisture, and the action of ordinary household chemicals. The baking schedule varies with the temperature, but at 325 deg. F., 15 min. is sufficient. Furnished in all plain colors and also in colors with metallic luster. Covers well in one spray coat or can be used over a primer. Supplied in types suitable for use on all metals and on many plastics. Maas & Waldstein Co., 438 Riverside Ave., Newark, N. J.

Oil Gage Plugs

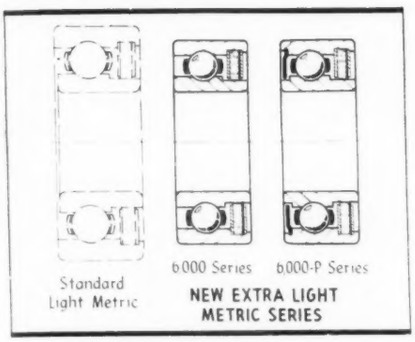
Two different types of gear case oil gage plugs have recently been placed on the market. Style "BW" Hex oil gages are turned from solid hex brass rod.



Shank threads are die cut and accurate. The glass disk is rolled between two heavy cork gaskets, insuring leak-proof joints. The "CW" flanged oil gage for flush mounting is turned from solid round brass rod. All parts of the "CW" gage shown here are individual and replaceable. Gits Bros. Mfg. Co., 1846–62 South Kilbourn Ave., Chicago, Ill.

Light Ball Bearings

Two new series of extra light ball bearings, designated as 6000 and 6100, have been designed for use on small high-speed units in which minimum weight is sought, center distances are restricted, and de-



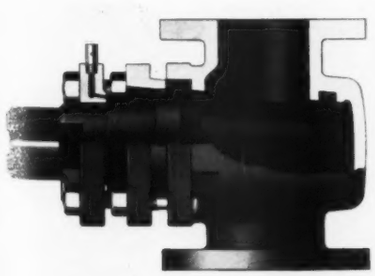
signers are cramped for space. For a shaft of given diameter, these new bearings permit the use of a housing of smaller diameter. Series 6000 felt-sealed bearings, shown here in comparison with standard light metric bearing, are available with or without shield and in sizes up to 25 mm. bore. Series 6100 is supplied with or without side plates, and in sizes up to 45 mm. Norma-Hoffmann Bearings Corp., Stamford, Conn.

Tracing Paper

Combining the transparency of oil treated sheets with the permanence of natural 100 per cent rag papers, this new type of tracing paper is treated with a new crystal clear synthetic solid called "Albanite." Because this new transparentizing agent is free from oil and wax, and is both chemically and physically inert, it is claimed that Albanene will not oxidize, turn yellow, become brittle, or lose transparency with age. The new chemical has remarkable penetrating power so that an extremely long fiber base paper can be used, giving an unusually high strength. Available in three weights, light, medium and heavy. Keuffel & Esser Co., Adams & Third St., Hoboken, N. J.

Groove-Packed Iron Cocks

This new type of asbestos groove-packed iron cocks has the usual gland to hold the plug in position and an additional gland to compress the top packing. Pressure on the plug and packing can be controlled separately. Results in a 50 per cent reduction in the effort required to operate and there is less wear on the moving parts. Alemite lubrication is provided through a groove between top of plug and top gland. Dual Gland cocks are made in sizes from 1½ to 6 in. for steam pressures of 125 and 250 lb. per sq. in. Reading-Pratt & Cady Div., American Chain & Cable Co., Inc., Bridgeport, Conn.



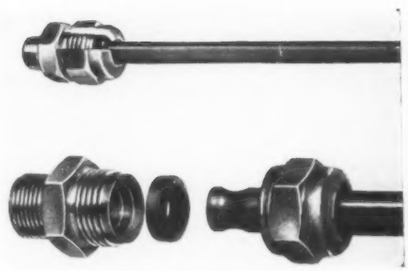
Multi-Breaker

A small, compact device that will serve as a service center or a load center for lighting or appliances assures over-current protection for farm, home and industrial machinery. Type "MO" multi-breaker is simple in construction and

operation, safe, tamperproof, and attractive. Box can be furnished with grounded neutral, insulated neutral, or no neutral. Supplied for either surface or flush mounting. Designed for 15, 20, or 25 amp. Colt's Patent Fire Arms Mfg. Co., Hartford, Conn.

Flexible Fitting

For use with copper, steel and aluminum tubings, this new flexible fitting can be used to replace flexible joints and flexible hose in certain types of installations. Design is such that no special tools are required to install it, and no more than ordinary care is required to disconnect the fittings frequently without causing leaks. Tube is held firmly by a highly compressed, rubber-like gasket in such a way that the tube is allowed to move slightly as in a ball and socket joint. VibraSeal flexible fitting is made in four styles; low pressure fitting for up to 400 lb. per sq. in.; high pressure fitting for hydraulic lines; aircraft fittings



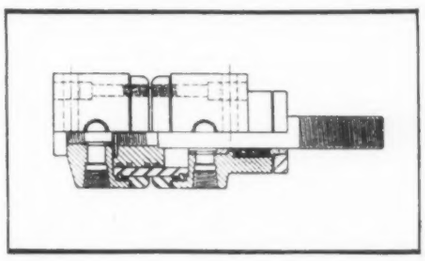
for safety fuel and oil lines in aircraft construction; special types for corrosive materials. VibraSeal Corp., 2832 East Grand Blvd., Detroit, Mich.

Hammered-Effect Finish

A new marproof hammered-effect finish, designed for use on rough or porous metals, will cover defects in the metal, such as spot weld marks and file scratches. While it has the effect of a rough finish, its surface is actually smooth. Known as Polymeroid, it is made with a Polymerin base, and has good heat-resistance, durability, and adhesion characteristics. Although two operations are involved in its application, Polymeroid is essentially a one-coat finish. The first coat is applied with a spray gun, and while it is still wet, another coat is sprayed on. Available in all colors. Ault & Wiborg Corp., 75 Varick St., New York, N. Y.

Logan Cylinder

New Logan hydraulic cylinder is small, neat, compact, and rigid. No conventional gaskets are used in its construction. A revolutionary sealing principle is used which automatically seals so that the greater the pressure, the greater the sealing. End flanges are so constructed that pipe connections can be made from any



direction. Alloy steel and nickel iron castings used throughout. The cylinder, which may be furnished with adjustable cushions at each end or at both ends of the stroke, has self-sealing rod packing. Available for hydraulic oil or water service, in all styles of mounting. Logansport Machine, Inc., Logansport, Ind.

Manufacturers' Publications

BALL BEARINGS—Fafnir Bearing Co., New Britain, Conn. Bulletin, 8 pages, 8½ x 11 in. Shows and describes entire line of Fafnir ball bearing lineshaft boxes. Complete details and specifications are given.

BEARINGS—Bunting Brass & Bronze Co., 715 Spencer St., Toledo, Ohio. Catalog 39, 52 pages, 8½ x 11 in. Complete listing of standardized stock bearings, bronze bars, babbitt, electric motor bearings and bearings requiring special operations are given in this catalog.

BEARINGS—New Departure, Div. General Motors Corp., Bristol, Conn. Machine Tool Handbook, 200 pages. Contains descriptions, dimensions, capacity ratings, and mounting data for 20 types of New Departure ball bearings used in machine tools, including 7 types designed for precision machines. Data for bearing selection and application is included.

BEARING BRONZE—Johnson Bronze Co., 310 So. Mill St., New Castle, Pa. Dimension listing, 8 pages, 5 x 16½ in. Lists 329 sizes of Johnson Universal bronze bars carried in stock, and 29 stock sizes of solid bronze bars.

BOLTS—Clark Bros. Bolt Co., Milldale, Conn. Catalog 39, 90 pages, 6¼ x 9¼ in. Gives list prices, tables and helpful information covering complete line of bolts, nuts, screws and rivets.

CENTRIFUGAL CLUTCH—Dawes Equipment, Inc., 2280 Penobscot Bldg., Detroit, Mich. Bulletin H-75-6-39, 4 pages, 8½ x 11 in. Fully illustrates and describes the new D-E automatic industrial power drive clutch of the centrifugal type.

CHAINS AND SPROCKETS—Whitney Chain & Mfg. Co., Hartford, Conn. Catalog V-135, 64 pages, 8½ x 11 in. Gives complete information for the selection and design of silent chain drives, including engineering data, dimensions, horsepower ratings and sprocket data.

COMPRESSORS—Ingersoll-Rand Co., 11 Broadway, New York, N. Y. Bulletin 7502-J, 8½ x 11 in. Contains installation and shop views of new industrial Type 30 compressors, size ¾ to 5 hp., and covers complete operating and physical characteristics of each.

CONTROLLERS — Foxboro Co., Foxboro, Mass. Bulletin 184-3, 31 pages, 8½ x 11 in. Covers Rotax Controllers for control of temperature and humidity, giving complete technical data, schematic diagrams and illustrations of applications.

COPPER ALLOY—Bridgeport Brass Co., Bridgeport, Conn. Index of the Copper Alloy Bulletins for 1938, 4 pages, 8½ x 11 in. Indexes for convenience of reference all the subjects covered in the Copper Alloy Bulletin, which appears regularly in *Product Engineering*.

ELASTIC STOP NUTS—Elastic Stop Nut Corp., 1015 Newark Ave., Elizabeth, N. J. Catalog 1939, 56 pages. Explains graphically the elastic stop principle, and contains comparative test data, illustrations of applications, and complete listing of standard nuts available.

DOWMETAL—Dow Chemical Co., 919 Jefferson Ave., Midland, Mich. Dowmetal Data Book, 8 x 11 in. Contains new information concerning the forming of Dowmetal, covering such operations as bending, roll forming and die drawing, hand forming, power pressing and drawing, die design, spinning, and forming of extruded shapes.

FLEXIBLE COUPLINGS—Certified Flexible Couplings, Inc., 122 E. 42nd St., New York, N. Y. Pamphlet covers recent addition to the line of flexible couplings, including the No. 4R coupling, which has a steel ring inclosing the rubber into a compression chamber.

FORGINGS WEIGHT CALCULATOR—Kropp Forge Co., 5301 W. Roosevelt Rd., Chicago, Ill. Handy slide-rule type calculator for rapidly determining the weight of forged square, round, hexagonal and octagonal flats; also bars, forged rings and blanks.

GATE VALVES—Crane Co., 836 So. Michigan Ave., Chicago, Ill. Circular 311, 4 pages, 7¾ x 10⅝ in. Describes new Crane line of 200 lb. brass gage valves made with wedge disk, union bonnet and rising stem, known as No. 422 and No. 423, recommended for steam, water, oil or gas lines.

INSULATION—Wilmington Fibre Specialty Co., Wilmington, Del. Bulletin, 4 pages, 8½ x 11 in. Illustrates and describes vulcanized fibre grommets, upset washers, and bushings for use wherever current-carrying wires pass through metal.

MAGNET WIRE—General Electric Co., Schenectady, N. Y. Bulletin GEA-2973, 4 pages, 8½ x 11 in. Covers Formex wire, describing the tests used for measuring the ability of an insulating film to maintain its integrity, and setting forth the properties of Formex.

MEEHANITE—Meehanite Research Institute of America, Inc., 311 Ross St., Pittsburgh, Pa. Bulletin 9, 16 pages, 8½ x 11 in. Contains 7 charts of engineering properties and 29 photographs of various applications of Meehanite.

MOTOR BASES—Rockwood Mfg. Co., 1801-2001 English Ave., Indianapolis, Ind. Booklet 861, 16 pages, 8½ x 11 in. Describes, with illustrations and dimensional data, various types of pivoted bases for mounting of motors and gas engines.

MOTORS—General Electric Co., Schenectady, N. Y. Bulletin GEA-1326D, 4 pages, 8½ x 11 in. Describes and illustrates totally inclosed fan-cooled induction motors, available in all standard ratings from 2 to 75 hp.

PILOT WIRE RELAYS—General Electric Co., Schenectady, N. Y. Bulletin GEA-3237, 8 pages, 8 x 10½ in. Sets forth features, applications and characteristics of pilot wire relays, Type IJD, triple-pole, for protection of a.c. lines.

PLASTICS—Chicago Molded Products Corp., 1023 N. Kolmar Ave., Chicago, Ill. "Plastics Progress," 8 pages, 8½ x 11 in. First issue of a bulletin to be published regularly with the purpose of supplying users of plastic molded parts with information of value gathered from the field.

PULLEYS—Rockwood Mfg. Co., 1801-2001 English Ave., Indianapolis, Ind. Bulletin 860, 15 pages, 8½ x 11 in. Complete list of stock sizes and prices of Rockwood paper pulleys. Contains information for the proper specification of Rockwood pulleys.

SOLENOIDS—Dean W. David & Co., Inc., 549 Fulton St., Chicago, Ill. Catalog 10, 8 pages, 8½ x 11 in. Covers custom-built solenoids, coils and transformers, giving technical information and illustrations of application to modern machines.

SPEED REDUCER—Mechanical Handling Systems, Inc., 4600 Nancy Ave., Detroit, Mich. Catalog D-2, 12 pages, 8½ x 11 in. Sets forth advantages and features of MHS Universal Multi-Ratio drive units, horizontal and vertical types.

SPEED REDUCER—W. A. Jones Foundry & Machine Co., 4401 Roosevelt Rd., Chicago, Ill. Bulletin 75, 16 pages, 8½ x 11 in. Gives general description, illustrations, and engineering data on the new Jones worm-helical speed reducers.

STEEL—Bethlehem Steel Co., Bethlehem, Pa. Catalog 152, 24 pages, 8½ x 11 in. Mayari R high strength corrosion resisting steels for applications requiring light weight and resistance to abrasion are described. Many photographs show applications.

STEEL—Joseph T. Ryerson & Son, Inc., 16th and Rockwell Sts., Chicago, Ill. General Data Book, 146 pages, 4½ x 8¼ in. Contains metallurgical definitions, heat, hardness and numerical equivalent tables; weight, dimension and specific gravity tables; carbon steel, drill rod, non-ferrous, tubing, sheet, and manufacturing tolerances.

VARIABLE SPEED TRANSMISSION—Allis-Chalmers Mfg. Co., Milwaukee, Wis. Bulletin B-6013, 20 pages, 8½ x 11 in. Contains many installation views showing applications of Vari-Pitch speed changers, and includes dimension sheets, horsepower and speed range tables.

VARIABLE SPEED TRANSMISSION—Link-Belt Co., 307 N. Michigan Ave., Chicago, Ill. Book No. 1574, 40 pages, 8½ x 11 in. Two new sizes of P.I.V. Gear variable speed transmissions have been included in this new book which fully describes and illustrates these units.

WIRING DEVICES—Eagle Electric Mfg. Co. Inc., 59-79 Hall St., Brooklyn, N. Y. Catalog, 44 pages, 8½ x 11 in. Covers the complete line of more than 1,200 electric specialties and wiring devices.